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FUEL OIL FOR STEAM BOILERS

Methods and Devices used for the Generation of Steam

The use of oil as a steam boiler fuel has generally been limited to those portions of the country in the proximity of the oil wells, but with the discovery of the large quantities of petroleum in Texas and California, the field for oil burning apparatus has been considerably enlarged. The quantity of oil discovered around Beaumont, Texas, alone is about 6,000,000 barrels per day, with no indication of its being soon exhausted, so that there has been a rapid growth of oil burning power plants in Texas and California.

That its use has not been greater has been due principally to the fact that the cost of the freight for any large distance makes its price excessive, so that if it costs the consumer anything more than one dollar a barrel, it ceases to possess any monetary saving over the use of coal.

The properties of fuel oil vary with the locality in which it is found, but in general, good oil may be said to possess the following properties:

Specific gravity	22° Baume.
Weight per gallon	7.66 lbs.
Weight per barrel (42 gallons)	322 lbs.
Flash point	180° F.
Fire point	200° F.

The value of oil as compared with coal varies somewhat with the nature of the work to be done. An average ratio can be established only when all the conditions are known, but in a general way it may be said that from 3½ to 4 barrels of oil are equivalent to a ton of 2000 pounds of good soft coal. The advantages claimed for oil are as follows: Diminished loss of heat up the chimney owing to the clean condition in which boiler tubes can be kept, and to the smaller amount of air which has to pass through the combustion chamber for a given fuel consumption; a more equal distribution of heat in the combustion chamber, as the doors do not have to be opened, and consequently a higher efficiency is obtained; unequal

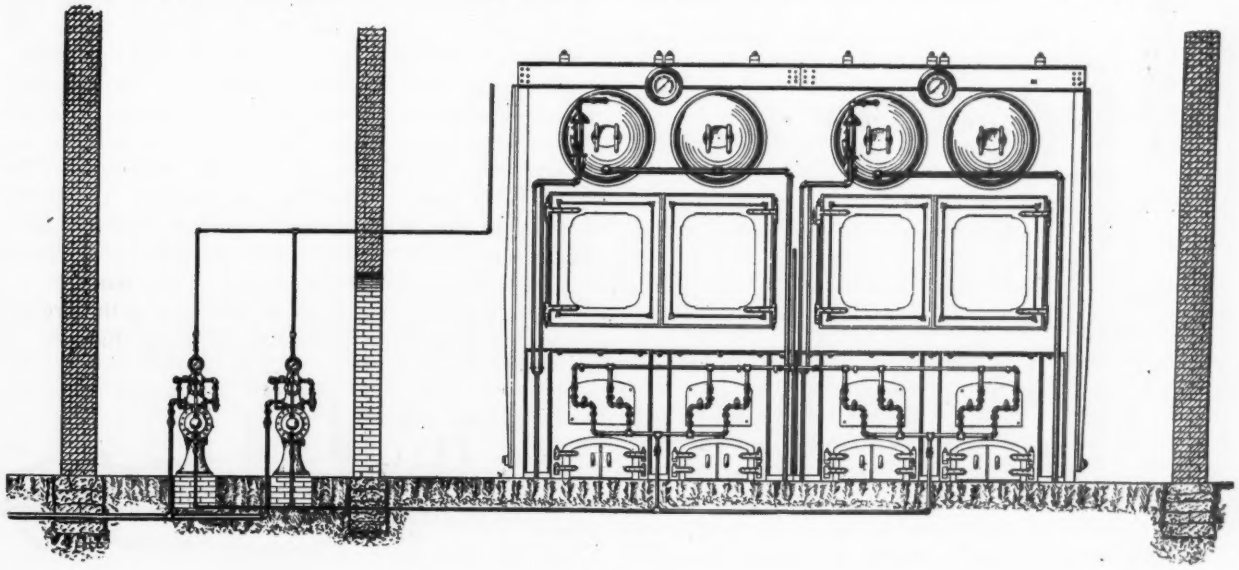


Fig. 1.

strains on boiler tubes, due to unequal heating are also avoided; there is no danger of a dirty fire on hard runs; a reduction in the cost of handling fuel; absence of dust, ash or clinkers; no firing tools being required, lining and brick work will last longer; ease with which the fire can be regulated from low to intense heat in a short time; greater increase in steaming capacity for a given boiler.

The disadvantages which have prevented its general adoption are as follows: The use of crude oil has been prevented by city ordinances or fire departments in many places and where it is allowed, special methods must be used for placing the reservoir containing the oil underground and so placed that it cannot flow out of its reservoir in case of fire; the crude oil has an offensive odor and its use is prevented by health boards

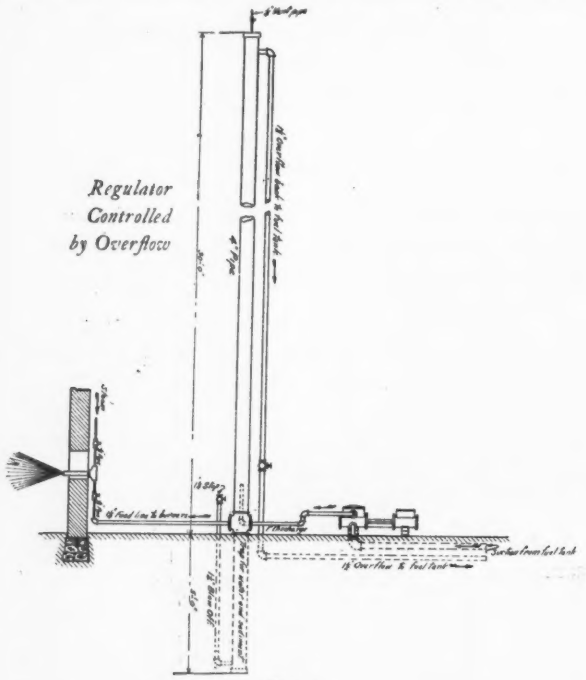


Fig. 2.

in certain cities, for this reason; the vapor from crude oil forms an inflammable or explosive mixture with air; the supply of oil is limited, which makes it usually more costly than coal; heating surfaces of boiler are apt to become coated with a deposit of incombustible matter in the oil; difficulties caused by leakage of the oil and the necessity for an auxiliary apparatus either to start the oil fire, or to maintain it, or both. If the oil is vaporized and carried by air, an air pump must be driven by the boiler itself to supply compressed air, and in starting, this must be furnished by independent apparatus. If steam induces the current of oil, an auxiliary boiler must be started by coal to give the necessary pressure.

When oil is burned, it will not burn as such but must be distilled or vaporized preceding the actual combination with oxygen. Different oil systems will therefore differ chiefly in the methods of producing the oil vapor and in the method of causing a meeting of this vapor with the air. The different classes into which oil burning systems may be divided are as follows:

1. The burning of the oil in an atmosphere without previous treatment by air or heat.

2. The burning of oil by vaporization and permitting a certain amount of air to mix with it before it reaches the flame, and having reached the flame, requires an oxygen atmosphere to support combustion.

3. The burning of the oil by explosions in which the oil is

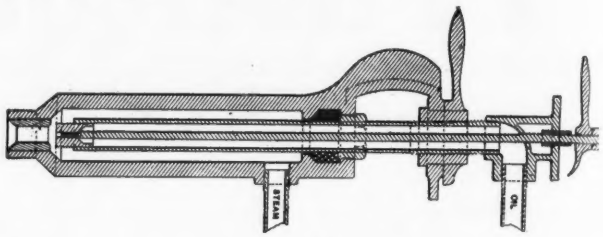


Fig. 3.

vaporized and mixed with air in such proportions and in such manner that there will result an explosive mixture of oil, vapor and air.

In the first system, the vapor burns immediately as formed and hence there can be no mixing of air, the flame existing merely in an atmosphere which is generally often renewed. The oil in this system burns from the surface of either a liquid mass or surfaces artificially produced by sand, stones or wicks of fibre or metal. This system can only be successful when oil is burned on a small scale and with light oils. The second and third methods are the ones mostly used and the success of burning oil depends upon the atomizing of the oil, so that the efficiency of any burner is proportionate to its power to atomize the oil and then turn these minute particles of oil into a mixture of combustible gas and fine particles of carbon.

The proper methods and conditions for burning fuel oil under boilers are as follows: 1. The oil used must be of sufficiently high fire-test. 2. The oil must be supplied to the burners under a sufficient and uniform pressure. 3. The oil should be preheated to facilitate atomization. 4. The burner should feed the oil in a finely atomized condition, which is usually accomplished by steam from the boilers. 5. The steam should be superheated before going to the burner. 6. The right proportion of air should be admitted to the fire-box or combustion chamber to completely burn the fuel, an excess

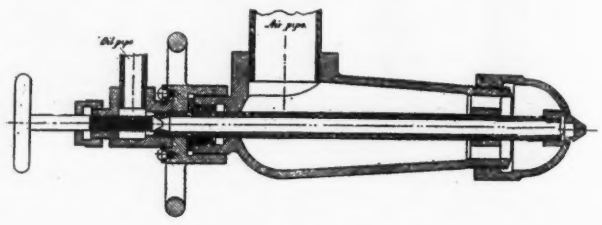


Fig. 4.

meaning loss of efficiency. 7. The flame from the burner should be directed against a wall of fire-brick.

In the use of oil as a fuel, one of the principal considerations is the equipment; the points to be attained being a steady pressure at the burners, perfect combustion, simplicity and cost of installation. There are two systems now in use, one a direct pressure system regulated by a valve on the pump, the other an indirect pressure system regulated by an iron pipe used as a pressure regulator and called a standpipe system.

This system is shown in Fig. 2. The pump takes its oil from the storage tank and forces it through the pressure regulator to the burners. The pressure regulator is provided with an overflow line back to the storage tank, which prevents the pressure from varying, as all oil handled by the pump in excess of that required by the fires is carried back to the storage tank by means of the overflow line. It should be provided with a trap at bottom which collects the water and sediment which may be removed by the blow-off, as shown.

The direct pressure system, with its connections to the boilers, is shown in Fig. 1. The storage tank is not shown but should be located so as to admit of the oil being discharged from the tank car by gravity. The storage tank should be located below ground with its top below the level of the burners. The pumping system should be placed in the pump room, engine room or other convenient location but not in the boiler room, and the oil delivery pipe carried along the front of the boilers below ground with a branch to each boiler.

Among the most prominent burners in use, some use steam and some use compressed air. When compressed air is not available, steam must be used, although the thermal efficiency of the burner is not increased by the use of steam. In this

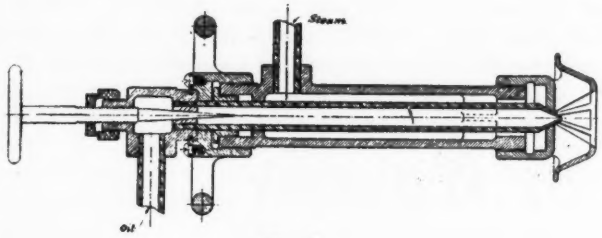


Fig. 5.

connection the Bureau of Steam Engineering of the U. S. Navy remarks as follows: "There is quite a widespread misconception regarding the part that the steam which is used for atomizing purposes plays in effecting combustion. It is supposed by many that, after atomizing the oil, the steam is decomposed and that the hydrogen and carbon are united, thus producing heat and adding to the heat value of the fuel. While it may be true that the presence of steam may change the character and sequence of the chemical reaction and result in the production of a higher temperature at some part of the flame, such an advantage will be offset by lower temperatures elsewhere between the grate and base of the stack. All steam that enters the furnace will, if combustion be complete, pass up the stack as steam, also carrying with it a certain quantity of waste heat. The amount of this waste heat will depend upon the amount of steam and its temperature at the entrance of the furnace. The quantity of available heat, measured in thermal units, is undoubtedly diminished by the introduction of steam. In an efficient boiler, it is quantity of heat rather than intensity that is wanted. For many manufacturing purposes, intensity of heat may be of primary importance, but in a marine boiler a local intense heat is objectionable on other grounds than those of economy; viz., its liability to cause leaky tubes and seams from the unequal expansion of heating surfaces."

Some of the more promient oil burners using both oil and steam are shown in the accompanying illustrations: Fig. 3 represents a section of a Kirkwood oil burner, which can be used with either steam or air. Fig. 4 represents an Oil City Boiler Works air burner and Fig. 5 represents a steam burner of the same make. Fig. 6 represents the Reed combined air and steam burner where both steam and air are used, but this has the objection of involving unnecessary expense and complication and requiring more skill and attention to adjust and manipulate the burners. Fig. 7 represents a section of the

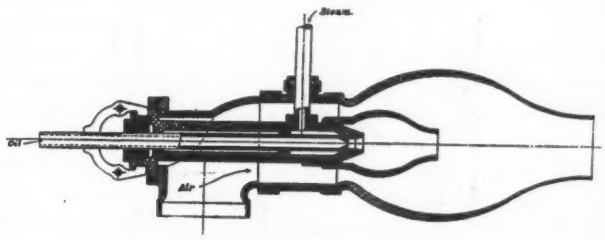


Fig. 6.

Gem burner. The oil enters at one side and passes out through the inner tube. The steam is admitted at the other side and surrounds the oil tube. It heats the oil in the tube and the jet formed at the outlet atomizes the oil. A whirling motion is given the steam by a whorl placed near the outlet which adds to the atomizing effect and delivers the oil in a fine spray or vapor.

The operation of oil burners depends upon the kind of burner and system used. The National Equipment Co., manufacturers of the Branch burner, give the following instructions for setting up and operating their burner—as shown in Fig. 8: 1. Cover the entire grate surface, with the exception of an open space under each burner, with fire-brick, filling up the crevices with fire-clay. Cinders can be used but fire-brick is preferable. The open space under the burners, of about 6″ x 10″, is to keep the burner cool and prevent any oil wasted in starting up from burning around the burner. 2. No target or spatter wall is necessary with this burner; it being claimed that a spatter wall is likely to burn the boiler, a few fire-

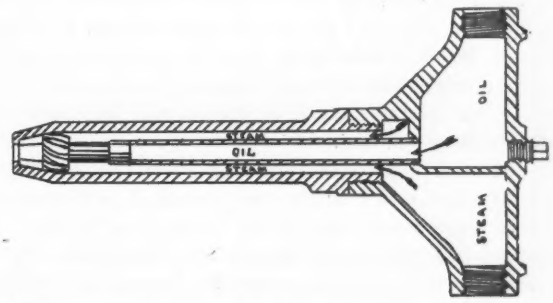


Fig. 7.

bricks in front of the burner to deflect the heat being sufficient. 3. One burner is sufficient for any boiler not exceeding 125 horse power; the burner should be inseated between the two fire doors. To do this it is necessary to drill one 1½-inch opening through the front of the furnace. The front nozzle of the burner should go entirely through the fire-liners into the furnace, the burner being held in position by the pipe connections made on the outside of the furnace. 4. The burner should be set about six inches above the surface of the fire-brick, if the furnace has no bridge wall. If there is a bridge

wall, then insert the burner so the flame will strike about the centre of the target wall placed directly in front of bridge wall. 5. No other change is necessary in the furnace. Keep the fire-doors closed and the ash-pit doors slightly open. To change from oil to coal, simply uncouple burner and rake out fire-brick. 6. Before lighting burner see that the damper is wide open and kept that way. If too much draft, close the ash doors or simply crack them. Never close damper when burning oil. If there is any smoke, give the burner more steam or less oil. 7. In starting, always first turn steam through the burner to heat it up, then turn on the oil and light burner, using waste dipped in oil.

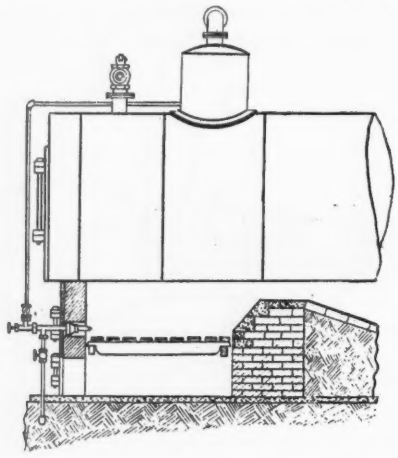


Fig. 8.

When a locomotive boiler is fitted with an oil burning device, it can be done as shown in Fig. 9. The target wall is built of fire-brick and prevents the fire from striking directly upon the flue sheet and burning it out. It also protects the ends of the flues from injury, when the burner is shut off, by preventing cold draughts of air from striking them when still hot.

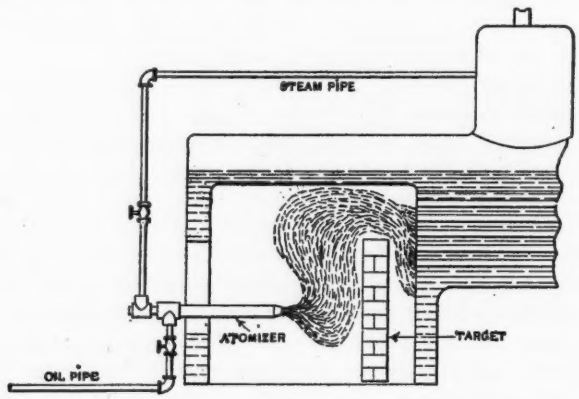


Fig. 9.

THE QUESTION OF ECONOMY

By E. H. Naylor.

In a steam plant, as a rule, it will almost invariably be found that a saving in some form or other can be made; not only in the proper distribution of the steam after it has left the boilers, or in the proper handling of the fuel, but in various other ways. It does not pay to assume that everything is all right, because what may pay in one plant will not be a success in another and it is here where false economy comes in. For instance, it might pay to use a cheaper grade of fuel in some plants, while the same grade of fuel if used in another plant would not be economical.

On the other hand, some will look at the cost of fuel only, despite the fact that a better coal, costing a few cents more, will give better results and be the cheapest in the end. Take a grade of coal which costs $4.35 a ton, delivered in the yard, and suppose it evaporates about 8.5 pounds of water per pound of coal with 15 per cent. ash and refuse. Then take another coal costing $4.50 a ton, delivered, and suppose it evaporates 9.5 pounds of water per pound of coal with only 10 to 12 per cent. refuse. The latter is certainly the cheaper coal to use, but still it is hard to convince some manufacturers that such is the case. They think that coal is all one thing under a boiler and any one who can use a shovel can do as well as a practical fireman.

It is often thought that some coal is terribly poor stuff and not much good because it clinkers under a hard worked fire. This is not correct, because no matter what kind of coal you use, if the fires are forced, more or less, there is sure to be some kind of clinker and the more heat there is in coal, the greater it will clinker; because it takes a hot fire to make a clinker, while a coal with less heat will go to soft ash, as a rule. Coal that will clinker some is easier to clean than coal that goes to soft ash, because the former can be broken up and pulled out, while with the latter the whole side has got to be hoed out to get any kind of a clean fire.

The efficiency of a vacuum is also misunderstood. A few years ago, the chief engineer of a large power house in my vicinity imagined he was not getting what he thought was the proper vacuum, so he had the old condenser taken out and a larger one put in at quite an extra expense. It was a failure as he could not get any better vacuum than before, but to make the owner think he had succeeded in improving the conditions, he set the vacuum gauge up 2½ inches, making it appear to them that he was getting 27½ inches when he was only getting 25 inches, the same amount as the old condenser had given.

Now, in this case, the old condenser was more efficient than the new one, because the new one required larger pumps and the larger pumps required more steam. Conditions did not suit for a larger apparatus. The chief engineer now in charge had made considerable improvement by filling some of the perforations in the spray pipe. This has been a good improvement and it goes to show that if the old condenser had had the proper care there would never have been any change needed.

It is often thought that 24 or 25 inches of vacuum is a very

poor one. This is not always so, because it depends upon conditions. It is all very nice to point to the vacuum gauge and say 27 inches, and then swell out with pride, but before doing so, the means by which it has been obtained should be considered.

Recently, the representative of a firm manufacturing a protector for the furnace front of a boiler called on the writer, guaranteeing certain claims for it. This protector consists of pipes cast into iron frames on each side of the door, through which the water circulates and which keeps the front nice and cool, making it comfortable for the fireman. Aside from this, if a plant is cared for in every detail, why surely the cheek and crown pieces will get their proper treatment. From what the writer has known it to cost for cheek and crown pieces, including the brick work and material, and the longest life of the protector, it would not pay to use them under the best conditions, but where the engineer in charge has to take firemen who will burn out a set of cheek and crown irons in a very short time, these protectors would be a great saving.

The oil question is one which is ever before the engineer. Very often the superintendent is attracted by certain offers of oil salesmen and he makes the engineer give the oil a trial, as it is claimed that very much less oil of a certain kind can be used. Here is where the drummer gets the engineer into trouble. Very often, the engineer can get along with less oil and is very likely to save a small amount of oil daily on each engine and pump, and if there are a number of engines in operation, quite a saving may be made daily, but how about the coal pile? Has this been taken into consideration in saving the oil and has the cost of the extra steam to overcome the extra friction been calculated?

An illustration of this is as follows: I was employed in a horse power engine on less than three drops per minute. large plant as assistant engineer and we had been using an excellent oil. We were at that time lubricating a large 600 Orders came from the superintendent, through the chief, to cut down on the oil. There were five other engines in the place in constant operation from Monday morning until Saturday noon. I was told I had to cut down one drop a minute and if that was not satisfactory, another oil would be used. We used a third less oil that month but the extra coal that was used would make a coal baron smile, because we were running on as little as was safe to depend on for proper lubrication before the cut down. Some other cheaper oil was then used and on four drops a minute with the new oil on the same engine, still more coal was burned. Where was the economy here? And yet it was hard to convince the superintendent that such was the case.

The plant of which I have charge at present contains an 18 x 42 Rollins automatic cut-off engine and has a piston speed of 707 feet per minute. I use a high price oil but I only use 7 gills of oil a day. I have been criticised for using oil at such a price. Nearby is a 15 x 38 engine of the same make, on which oil is used which costs one-sixth less, and while the engine has only a piston speed of 510 feet per minute, it costs exactly the same per day to lubricate both engines. Now, I contend that when the surfaces of the two engines are considered, as well as the difference in piston speed of nearly 200 feet per minute, the cheapest oil is the highest priced in the end.

It is also often claimed that it is better to pay 16 or 18 cents a gallon for oil and let the oil run on in a stream. It is claimed that as the oil can be filtered over and over againt, there is no waste. This is not so, for it takes oil a certain time to wear out and it wears according to its quality. Oil at the price just stated is a very poor grade, as a rule, for it is hard to get good kerosene for less than 12 to 14 cents per gallon, at the present time, and where the saving comes in, I fail to see.

Another point to be considered under the above heading is the installing of different steam-saving devices. Care and judgment must be used in this matter, and a plant must be of sufficient size to pay for the expense of installing the additional device. For instance, suppose a superheater was being considered for furnishing a 75 or 100 horse power plant with superheated steam. It might pay in a 400 or 500 horse power plant, but in the smaller plant the expense of the apparatus would be very much greater than the amount of steam saved. There are many other devices, however, that are good paying steam plant accessories.

Always thoroughly investigate the merits of any piece of apparatus before installation and be sure of what it is costing, and if installed on trial, be sure that there is a gain sufficient to allow it to remain in operation. In making calculations, interest on the investment, repairs and depreciation must be taken into account and then if 10 per cent. can be gained in economy, it is safe to call it a very good investment.

Mica as a Lubricant.

The properties of mica as a lubricant are not very well known, owing to the fact that it has only been used for this purpose during the past few years.

Mica as it occurs in nature is full of flint and foreign substances but when these impurities are taken out by a process known as air flotation, only the pulverized pure mica remains.

It is used for cooling hot bearings and on machinery in hot places, such as laundries and rolling mills. When used in cylinders, the mixture of mica and oil is fed through the lubricator in the ordinary way. It is also being used for high speed ball-bearing machinery.

It does not discolor the oil with which it is mixed, which allows the oil to be filtered. When used on a bearing, after the oil has been used up, the mica still remains and as it does not cake or harden, it leaves the surface of the bearing in a smooth and glossy state.

Receiver Space for Compound Engines.

In compound engines, all the space occupied by steam between the exhaust port of the high-pressure cylinder and the steam port of the low-pressure cylinder is called the receiver space. The amount of this space has no bearing on the economy of the engine, but the greater the receiver space, the more nearly horizontal the back pressure line of the high-pressure card and the initial line of the low-pressure card become.

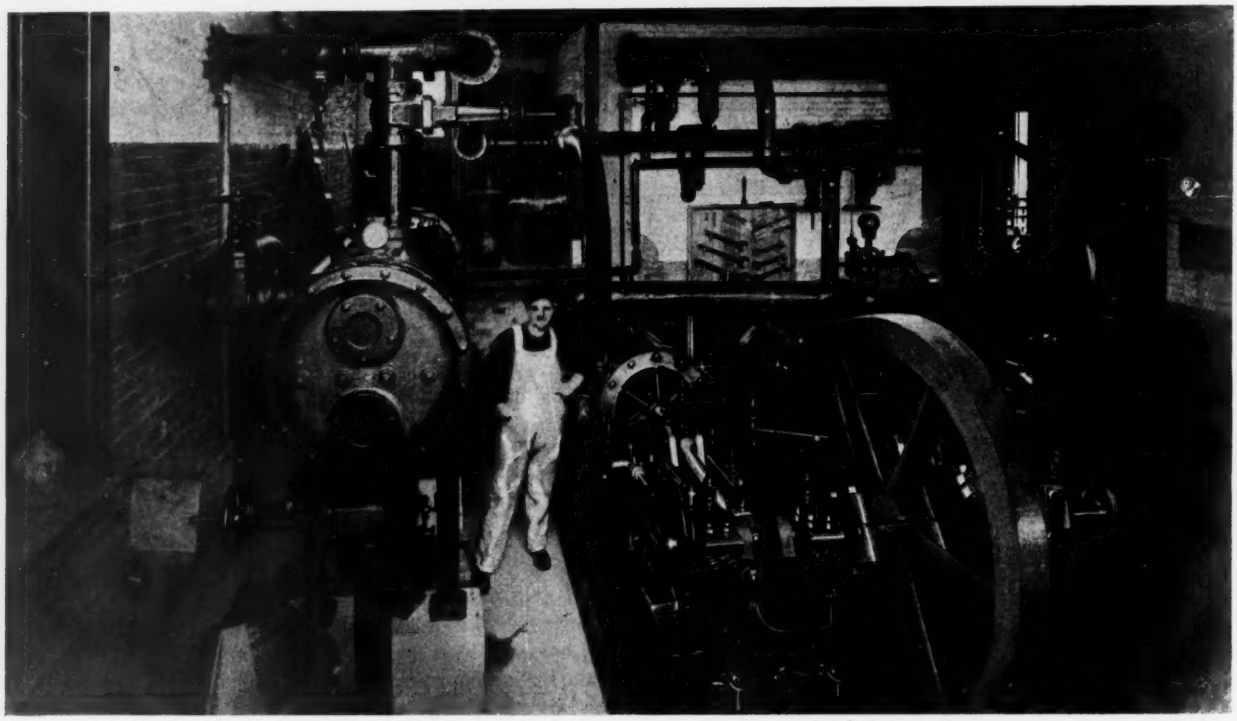
When iron is magnetized, it tends to retain its magnetism, and when the direction of the magnetism is reversed, power is required to affect this reversal. This is more prominent in hard iron than in soft iron and is known as the hysteresis loss.

PUMPING STATION AT SPRING LAKE, N. J.

An Air Lift Plant Supplying 2,500,000 Gallons of Water Daily

The air lift system of water supply has, after severe tests, proven its superiority over the ordinary methods of using deep well pumps, not only in cost of operation but from its simplicity and from the fact that the power plant can be placed at any desirable point without regard to the location of the wells.

The borough of Spring Lake, N. J., being compelled to increase its water supply, decided to either sink more wells or to install an air lift system. The old plant consisted of one horizontal return tubular boiler and a Worthington pump having duplex water cylinders, 10¼" x 10", and tandem compound steam cylinders, 9" x 14" x 10", connected to three wells. This pump could only deliver a combined volume of water of 125 gallons per minute. When the same wells were tested with air, they gave a volume of 310 gallons per minute each, from two wells, and 100 gallons per minute from the third well. The two wells giving 310 gallons per minute are 800 feet deep and cased with 8-inch pipe reduced at about 150 feet the surface to 6-inch pipe, having 4½-inch strainers. The well delivering 100 gallons was known as the 6-inch well and is 600 feet deep.



Interior of Pumping Station showing Compressor, Condenser and Piping.

The method of testing these wells was as follows: A single stage air compressor was placed in the pumping station and connected to the old boiler. The air tank was placed in a convenient position near compressor for ease of manipulation of the valves on the air pipes. The air pipes ran from the tank (no manifold being used as the cost of the test was to be kept at a minimum) to the wells, which were 250 feet and 375 feet from the building. The air pipe, which was one inch in diameter, was carried down in the well for a distance of 150 feet. The water pipe was 3½ inches in diameter and was carried down to the same depth, the arrangement being shown in the sketch. The discharge pipe had a goose-neck after leaving the well, to enable the water to be measured in barrels. The small well was piped the same way, having ¾-inch air pipe and 1½-inch water discharge, and the test showed that each 8-inch well was giving 310 gallons per minute while the 6-inch well was giving 100 gallons.

The air used in the air lift system gives not only an increased supply of water but the quality of the water is improved by aëration. An interesting point connected with putting on the air on the wells was noted. When the water first started to flow, it was very clear but at the expiration of 5 mintues it began to get dark in color and ran a light brown for 30 minutes. At the end of that time it became a very dark brown and for exactly 35 minutes it ran that way, after which it became as clear as crystal and as cold as ice, the flow steadily increasing. The test lasted 8 hours and after the wells were pumped for four consecutive hours, the flow in the wells exceeded the volume pumped by the air and at one hour before closing down the test, the water was holding its level, the compressor being speeded up to give a higher pressure, enabling the output and intake to equalize.

The Borough, after the test, decided to adopt the air lift system and the plant was consequently built as follows: One 150 horse power marine type boiler, one 12" x 22" x 12" x 14" Sweigard air compressor, one Barr surface condenser of 400

square feet cooling surface, one Worthington service pump 9" x 14" x 10¼" x 10", one Cochrane open feed water heater, one Barr duplex boiler feed pump and one Barr wet vacuum pump.

The exterior of the pumping station, as shown in the accompanying illustration, and as built, has a capacity of 965 cubic feet of air per minute or an equivalent in water of 2,500,000 gallons per 24 hours.

The boiler is of the internal furnace tubular type with Morison suspension furnace, its working pressure being 130 pounds. The diameter of the shell is 8 feet and its length 16 feet 8¼ inches; the thickness of the shell is ½-inch and the thickness of the heads is ⅝-inch; the diameter of the furnace is 50 inches and its thickness $^{15}/_{32}$-inch. It is rated at 150 horse power, having a grate surface of 30 square feet and heating surface of 1071 square feet, making the ratio of heating surface to grate surface, 35.7 to 1. The boiler contains 81 tubes, 3½ inches diameter, their length being 13 feet.

The combustion chamber of the boiler is lined on the sides and back with fire-brick. The trouble has usually been with this type of combustion chamber that the arch, which is supported by angle irons bolted to the back head of the boiler, is liable to fall, this being due to the corrosion of the angle iron, caused by the action of the gases. In this boiler, the builders, E. Keeler Co., eliminated this trouble by adopting a method of support as follows:

In place of the angle irons, the arch starts about 2½" to 3" above the tubes and in place of being parallel with the horizontal plane of the boiler it is arched in a perpendicular plane. When this arch is built, it is erected on wooden templates and after the joints are fairly set, the wood can be removed or left to burn out. This has proven to be a very satisfactory method of lining the combustion chamber.

The boiler is fed by both pump and injector, the feed pump taking water from the heater. The boiler has a dry pipe having slots, whose area is equal to three-quarters of the area of the steam pipe. The safety valve is of the standard marine type, spring balanced. The uptake in front of the boiler is cast-iron. The connection from the uptake to the stack is made through a rectangular iron flue made up of angle irons and plates. The boiler is furnished with a bottom blow, surface blow and hydro-kineter. The hydro-kineter is an absolute necessity, as the circulation in this type of boiler is, as a rule, very poor, causing leaks around the bottom of the girth seams unless circulation is stirred up by one of these devices.

The boiler is covered with magnesium covering 2¼ inches thick and all feed pipes leading to boiler are likewise covered with the same material. The feed water heater is of the Cochrane open type. The feed pump is of the Barr duplex type, outside packed, full brass fitted and takes its water direct from the heater. The heater stands on a foundation 2 feet above the pump, which gives a head of over three feet, preventing the flashing of the water into steam when the temperature rises above 212 degrees. In fact, the water at the check valve is about 212 degrees. The vent from the heater is carried vertically up to atmosphere but the back pressure formed by the water flowing in from the wet vacuum pump is sufficient to raise the temperature of the feed water to 213 degrees. The heater is covered to a depth of 2 inches with magnesia covering. All feed pipes have long square bends and flanged joints, the joints being made up with corrugated gaskets and litharge.

The air compressor is compound steam and duplex air, the steam cylinders having diameters of 12 and 22 inches, the air cylinders 12 inches, all having a common stroke of 14 inches. The valve gear is plain slide on high pressure and low pressure, the high pressure cylinder being fitted with Meyer cut-off valves. Metallic packing is used throughout. The details of the compressor are all built exceedingly heavy, so as to comply with severe mechanical and physical tests.

The surface condenser is of standard design, manufactured by the Barr Pump Works, and contains 400 square feet of cooling surface. The tubes are of composition tinned; the tube sheets are of brass; no steel or iron bolts are used, the fittings are all of the salt water type. There is no circulating pump, the circulating water being taken from discharge pipes of service pump. The Barr wet vacuum pump is of standard design and is full brass fitted. It pumps the water of condensation direct to feed water heater.

All pipes for steam are extra heavy and those for water are of standard thickness. The main steam pipe is 8 inches in diameter terminating in a steam main 12 inches in diameter. Cochrane separators are used on the steam pipe to compressors and pumps. To insure the separator wells being kept free from water, the pipe leading from the wells is carried to the auxiliaries and does not necessitate taking the steam direct from boiler. Between the condenser and atmosphere, a Shutte automatic exhaust valve is placed to prevent the destruction of the engine in case the vacuum should be lost or there should be any trouble with the condenser. The condenser can be cut out at any time while the plant is in full operation.

Exterior of Pumping Station

The exhausts of the auxiliaries are carried into the heater and supply all the steam necessary to heat the feed water. In case it should be desired, the exhaust lines are so designed that the exhaust from the service pump can be carried to the heater. On both the steam pipes to pump and compressor, there are back pressure valves provided.

The machinery was installed by J. L. Sweigard & Co., and the piping work was done by Bridgeman Bros. Co., both of Philadelphia. Mr. Chas. S. Linch was the engineer in charge of erection and design of the plant.

LATEST TYPES OF AMERICAN STEAM ENGINES

Buffalo Forge High-Speed Engines.

In many power plants, such as in large office buildings, space is of greater value than the most costly machinery occupying it, and it is in these places that the direct connected unit of engine and generator have received their largest application. Not only must these units be compact, but practice today demands that a high-speed engine should also have long life and good economy.

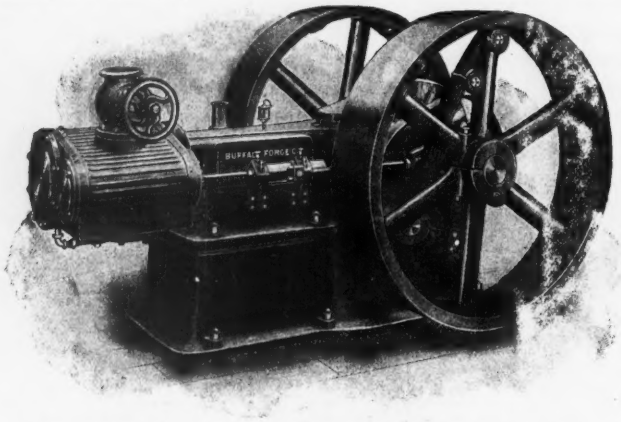


Fig. 1.—Horizontal Center Crank Buffalo Forge Engine, showing Governor Wheel and Valve Gear.

The Buffalo Forge Company are manufacturing several types of engines to meet these specific requirements, and they possess individual characteristics which adapt them for high speed service. These include the centre and side crank types of horizontal engines, simple and compound vertical engines, and simple and compound marine type upright engines. In the design of these engines, the principal features are simplicity of adjustment, compactness, accessibility of parts, and copious lubrication.

The horizontal centre crank Buffalo Forge engine is shown in Fig. 1. The engine proper is mounted on a sub-base which raises the fly-wheels clear of the floor. The frame of the engine is made of cast-iron to which in smaller sizes the cylinder is cast, but which in sizes above 8 inches in diameter, only one cylinder head is cast to it. The main bearings are set at an angle of 45 degrees to the vertical, as shown in Fig. 2, thus producing rigid bearings, and at the same time allowing for adjustment of the wear. They are lined with Babbitt metal, peened in, and bored square with the cylinder and scraped to a finish.

The crank shaft is a forging of open-hearth steel with balancing discs. The connecting rod is of forged steel, the crank end being of the locomotive strap type, and cross-head end solid with the wedge take up. The cross-head fits bored guides, and is provided with Babbitt metal surfaces on the shoes which are adjustable for wear with a screw and lock-nut attachment. The cylinder and valve chest are cast in one piece. The piston, which is cast hollow, is fitted with snap rings. The steam chest after boring is fitted with iron bushings. These are drawn into place, bored, counterbored, and reamed, and can be replaced when worn.

The valve is of special design. It consists practically of two pistons, each having its entire bearing surface formed by a single snap ring, which is clamped between two side plates. The two pistons are fixed upon the spindle so as to permit independent adjustment. The eccentric motion is transmitted to the valve stem through a cross-head which works in bearings. The valve motion is derived from a swinging eccentric controlled by a shaft governor. The governor is of the inertia type, extremely simple and accurate. The mean speed of the engine can be regulated by shifting the position of the link, or by altering the tension of the spring.

The setting of the valves for this engine is a comparatively simple operation. First, place the valve stem cross-head in the centre of its stroke, midway between the guides, and block it fast. Then screw in the valve stem until the valve is in its central position, and fasten it there with the check nut. Take out the block that holds the valve stem cross-head, and couple the eccentric rod to the pin on the cross-head, the governor parts all being in position. Turn the fly-wheel and note whether the valve travels an equal distance on each side of its central position. If it does, the eccentric rod is the proper length; but if it does not, the length of the rod must be changed. When the eccentric rod has been adjusted to the proper length, the valve is set.

The method of oiling the centre crank engines is done by the revolving crank discs, with their peripheries dipping slightly in oil, which spray continuously the guides and whole interior of the bed. In this way, lubricant is supplied to an oil cup on the cross-head which feeds the wrist pin through a hole in the pin itself. A vertical duct in the end of the rod also

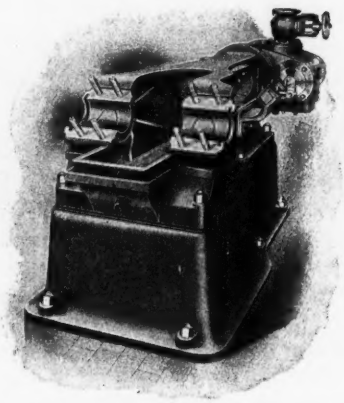


Fig. 2.—Arrangement of Main Bearings.

leads to this part. Two interior frame pockets are likewise kept filled with oil, and communicate through large passages directly with the main bearings. After passing through these bearings, the oil is caught and returned to the crank pit, although on one side the oil first passes within the hollow swinging eccentric whence it is supplied by centrifugal force to the strap bearing surface. The outboard bearing are oiled with a

ring oiling and self-aligning type of lubricator, and the valve rod bearings and eccentric rod pin are lubricated by two sight feed oil cups and a grease cup. The cylinder and valve are lubricated with a sight-feed lubricator.

Of the various types of vertical engines manufactured by the Buffalo Forge Company, that shown in Fig. 3 represents a unit which is used for general power work, and is often directly connected to electrical generators. It combines the advantages of the vertical engine in taking up small space, and its compound feature gives the greater economy which is often demanded in some grades of service. The cast-iron frame, which carries the cylinder and valve chests, supports the main bearing, and furnishes guides for the cross-head.

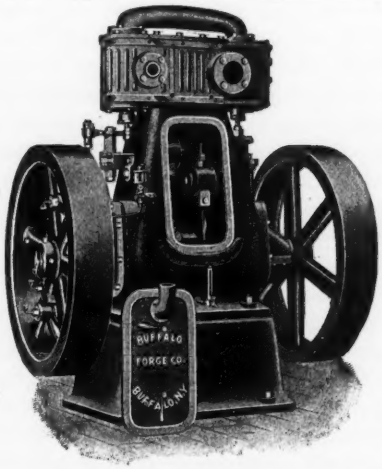


Fig. 3.—Vertical Cross-Compound Buffalo Forge Engine.

The two cylinders with their respective valve chests are a single casting bolted to the frame. A single piece cast-iron receiver conveys the exhaust steam from the high pressure cylinder to the low pressure steam chest. Steam distribution of the low pressure cylinder is controlled by a "D" slide valve, which is fitted with a pressure plate, so as to be as nearly balanced as possible. This valve receives its motion from a fixed eccentric and therefore always gives the same cut-off. The high pressure valve is of the piston type, which is controlled by the same type of governor used on the simple engine described above.

Working on slides, which are a part of the frame, are the two slipper-guide cross-heads. They are constructed of steel with wrist pins of machine steel, ground to a taper, fit and held in place with jamb nuts. The upper end of each connecting rod is solid, being provided with brass boxes and wedge adjustment, the lower ends being of the marine type. The shaft is of forged steel with cranks at 180 degrees running in long boxes, bolted to either side of the bed. These bearings are constructed so that they are adjustable, and are fitted with removable oil tight caps and oil rings, the oil from the bed being carried to the crank shaft by the rotation of the shaft.

The lubrication of the interior parts is effected by running the engine with a bath of oil in the bottom of the bed. The spraying action set up by the rotating shaft supplies the oil to every part within the frame. The guides are thus continuously lubricated, while short passages of ample diameter communicate directly with the other bearings. Outside of the frame sight-feed lubricators and oil cups feed the cylinder, eccentric and other bearing surfaces.

THE INCANDESCENT LAMP SITUATION

Some Facts about the Carbon Filament, Nernst and Metallic Filament Lamps

The incandescent lamp situation at the present time is most interesting owing to the advent of the comparatively recent Nernst lamps and the very recent advent of metallic filament lamps. In this country, about 250 central stations are using the Nernst lamp, while all the others are using the carbon filament lamps, the metallic filament lamps as yet only being used abroad. Of these latter types may be mentioned the tantalum lamp, the osmium lamp and the zirconium lamp.

At the recent meeting of the Ohio Electric Light Association, the Nernst lamp, the tantalum lamp and high-efficiency carbon filament lamps were discussed and the discussion showed that the carbon incandescent lamp will not alone hold the supremacy in the future as it has in the past and it behooves the operating engineer to get acquainted with some facts regarding each type of lamp.

Even with the carbon incandescent lamp there is a wide difference of the kind on the market. The cheapest lamp is not always the most economical, since some lamps of this type burn 3.5 watts per candle power and others as low as 3 watts, and if the cost of electric energy is high, it pays to buy lamps of high efficiency and replace them more frequently, than it does to burn low efficiency lamps for long periods.

The new metallic filament lamps with their low power consumption have caused the carbon filament lamp manufacturers to see where their type can be improved, with the result that a 2.5 watt per candle power lamp is now a possibility. The filament of this lamp is obtained by applying an additional process to the present carbon filament which includes heating in an electric furnace to a temperature of 3000 to 3700 degrees Centigrade, this firing being performed both before and after treatment. This results in producing an exceedingly pure form of carbon having considerably less specific resistance and greater density than the older filament. The process also changes the temperature coefficient from negative to positive and for this reason the term "metallized" has been employed to describe the new filament, although it contains no metal.

The Nernst lamp, which is essentially a reflector lamp, occupies a position midway between the 3.1 watt and 3.5 watt incandescent lamp, although an efficiency of double the ordinary incandescent lamp is often claimed for it. This divergence of opinion is probably due to the fact that each type of lamp throws out its maximum light in certain directions, and in comparisons of candle power, the methods of arriving at results are very different.

A very complete test of the new tantalum lamp in comparison with a 3.1 watt carbon filament lamp was the subject of a paper read by Prof. Wm. Ambler, and the results of tests made on two tantalum lamps, one having a clear and the other a frosted globe, are as follows:

The first test was on the change of resistance with change of voltage at the terminals of the lamp. In Fig. 1, curve *T* is that of a tantalum lamp, and curve *C* that of a 3.1-watt carbon filament lamp, each rated at 110 volts. These curves show that the tantalum filament increases in resistance with an

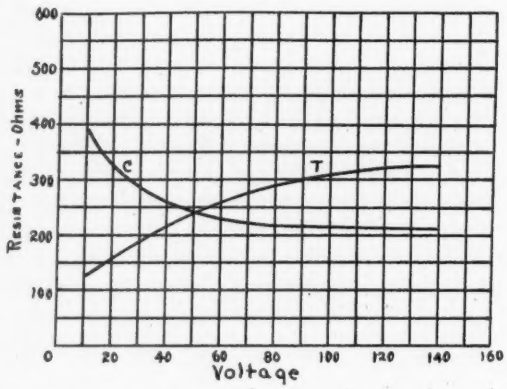


Fig. 1.—Variation of Resistance with Voltage.

increase of voltage, and, therefore of current and temperature, while the resistance of the carbon filament decreases as the temperature increases.

Measurements were made on the distribution of light from the tantalum lamps with both clear and frosted bulbs, and comparisons made with the light distribution from a 16-candle power, 110-volt lamp with clear bulb and with a single-curl carbon filament. The horizontal distribution of light from each of the tantalum lamps was found to be practically uniform. The lamp with the clear bulb gave 22.0 for the value of the mean horizontal candle power. The current at the rated voltage, 110, was .35 ampere, making 385 watts, or 1.75 watts per mean horizontal candle power. The frosted lamp gave a mean horizontal candle power of 19.8 and took .36 ampere at 110 volts, making 396 watts and 2.0 watts per candle. The rating given on the lamps is in the German or Hefner units, one unit of which amounts to .88 of the English unit of candle power. Values of candle power are given throughout in English units.

In Fig. 2 are given the curves showing the vertical distribution of light from the three lamps. Curve *C* is of the tantalum lamp with clear bulb, curve *B* of the tantalum lamp with frosted bulb, and curve *A* for the carbon-filiment lamp. Data for these curves were obtained by taking measurements of candle power every ten degrees from the horizontal. While the tantalum lamps give much more light in a horizontal direction, the amount from the tip of the lamps is much less than that from the carbon filament lamp, though this is one with a single-curl filament. The tantalum lamp with the frosted bulb gives a much better distribution of light than the one with the clear bulb, as shown by the curves.

The mean spherical candle power of the tantalum lamp with clear bulb was 17.2, requiring 2.23 watts per mean spherical candle power. The frosted lamp gave 14.82 mean spherical candle power at 2.67 watts per candle. The carbon lamp gave 13.32 means spherical candle power, requiring 3.72 watts per candle. Comparing these values we find that the tantalum lamp takes 57 per cent. and the frosted lamp 64.5 per cent., as many watts per horizontal candle power as the carbon lamp. The carbon filament lamp has a consumption of 3.1 watts per horizontal candle power. Also, the tantalum, with clear bulb, takes 60 per cent. and the frosted lamp 72 per cent. as many watts as the carbon lamp per spherical candle power.

Measurements were next made to determine the variation in the candle power with the voltage. The results are shown in the form of curves in Fig. 3. Values in per cent. of normal voltage were taken as abscissae, and values in per cent. of normal candle power as ordinates. Curve *T* is for the tantalum and curve *C* for the carbon filament lamp. The curves are similar, but the curve for the tantalum lamp is more nearly horizontal, showing that the change in candle power is much less than that of the carbon lamp for the same change in voltage. An increase of 4 per cent. in the voltage caused an increase of 24 per cent. in the candle power from the carbon lamp, while the same increase in voltage caused only a 9 per cent. increase in the candle power from the tantalum lamp. It requires practically twice the percentage change of voltage across the tantalum lamp as that across the carbon lamp to cause the same change in light. This wide difference in the variation of candle power with voltage is due to the decrease in resistance of the carbon filament, and the increase in resistance of the tantalum filament with the increase in voltage.

Fig. 4 shows the variation in consumption with the voltage. Values of watts per candle are taken as ordinates and per cent. of normal voltage as abscissae. Referring to the curve *C* for the carbon lamp, it is seen that an increase in voltage of 5 per cent. will cause a decrease in the number of watts per candle from 3.1 to 2.62, an increase in efficiency of 30 per cent. The same increase in voltage across the tantalum lamp would

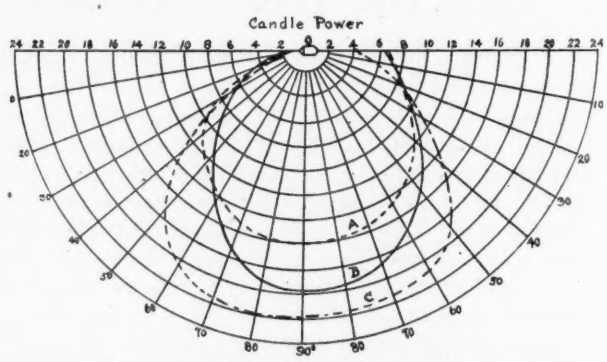


Fig. 2.—Vertical Distribution of Light.

cause a decrease in watts per candle from 1.75 to 1.62, an increase in efficiency of about 12 per cent. With a decrease in voltage there results a corresponding decrease in efficiency.

The relation between candle power and life of the carbon and tantalum lamps is shown in Fig. 5 by the two upper curves. Candle power values are taken as ordinates, and time of burning in hours as abscissae. The curve for the tantalum lamp was the average of three lamps, the curve for each lamp differing only slightly from the average. The curve for the carbon lamp is the average of a large number of 3.1 watt lamps. During a life of 1000 hours the tantalum lamp decreased in

candle power from 22 to 15.8, while the carbon lamp decreased in candle power from 16.5 to 11.5. This amounts to about 28 per cent. in each case. These results show then that the falling off in the candle power of the tantalum lamp is practically the same as in the case of the 3.1 watt carbon lamp.

The two lower curves in the same figure show the change in consumption with life. The watts per candle taken as ordinates were obtained at the same time as were the measurements for the two upper curves. During the 1000 hours the watts per candle increased from 1.75 to 2.4 in the case of the tantalum lamp and from 3.1 to 4.2 for the carbon lamp. This increase amounts to 37 per cent. for the tantalum and 33 per cent. for the carbon lamp. If we multiply the watts per candle by the corresponding candle power we find that the power taken by both the tantalum and the carbon is practically constant during the life of the lamp, a slight decrease occurring in each case.

In regard to the cost of the tantalum lamp, the representative of the German owners states that the lamps have not been placed upon the market in this country and that consequently no figures on the cost here are available. The cost of the lamps in Germany in barrel lots is 80 cents, as compared with about 16 cents for the ordinary lamp. Assuming this same

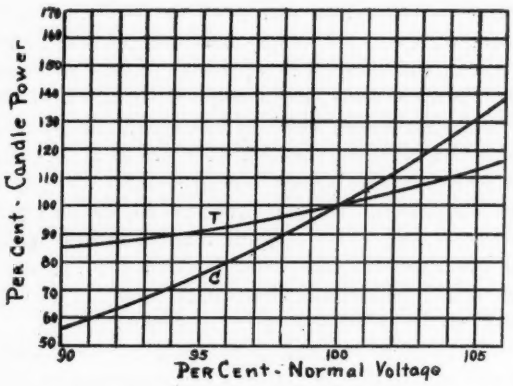


Fig. 3.—Variation of Candle Power with Voltage.

relation between values to hold in this country, some comparisons were made. The useful life of each lamp may be taken as 500 hours. The average candle power for that time is 19.87 for the tantalum lamp with clear bulb, 17.88 for the tantalum lamp with frosted bulb, and 15.37 for the carbon lamp. The average watts per candle are 1.86, 2.12, and 3.25 respectively. Assuming energy at 10, 5, and 3 cents per kilowatt hour, the relation in cost can be expressed as follows:

Cost of energy per unit	$ .10	$ .05	$ .03
Tantulum lamp, clear bulb	$ .80	$ .80	$ .80
Energy for 500 hours	1.85	.93	.62
Cost of lamp and energy	$2.65	$1.73	$1.42
Tantulum lamp, frosted bulb	.80	.80	.80
Energy for 500 hours	1.90	.95	.63
Cost of lamp and energy	$2.70	$1.75	$1.43
Carbon lamp	.16	.16	.16
Energy for 500 hours	2.50	1.25	.83
Cost of lamp and energy	$2.76	$1.41	$ .99

Dividing the cost in each case by the average candle power, we obtain the relative cost and saving or loss by the use of the tantalum lamp. Taking the cost of energy as 10 cents per unit, 2.65 ÷ 19.87 gives the cost per candle for 500 hours for the clear tantalum lamp as 13.3 cents. This amounts to a saving of 26 per cent. over the carbon lamp; 2.70 ÷ 17.88

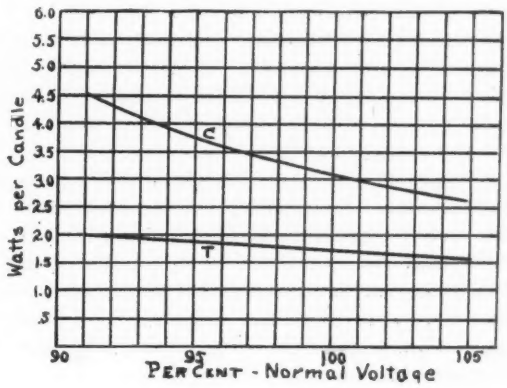


Fig. 4.—Variation of Consumption with Voltage.

gives the cost per candle for 500 hours for the tantalum lamp with frosted bulb as 15.1 cents. This amounts to a saving of 16 per cent.; 2.76 ÷ 15.37 gives the cost per candle for 500 hours for the carbon lamp as 18 cents.

Carrying out the work in the same manner when energy is taken at 5 cents per unit, we find that the saving by the use of the tantalum lamp with clear bulb over the carbon lamp is 5.2 per cent.; by the use of the frosted tantalum lamp there is a loss of 6.7 per cent. With energy at 3 cents per unit, there is a loss of 11 per cent. by the use of the clear tantalum lamp, and a loss of 23 per cent. by the use of the frosted lamp.

These results show that there will be a saving by the use of the tantalum lamp only when the cost of energy is above or about five cents per unit.

If we speculate upon the possible value of this new lamp we should consider the value of burned-out lamps. Allowing 50

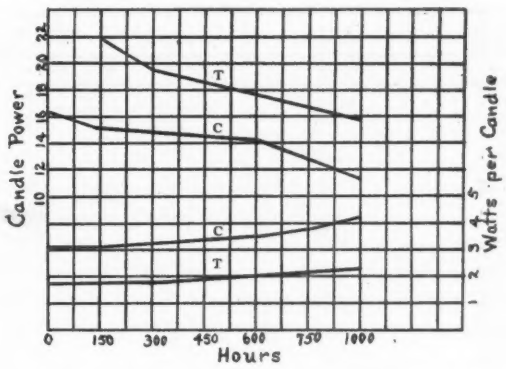


Fig. 5.—Life Test of Tantalum and Carbon Lamps.

per cent. of the original cost as the value of the lamp, there will be found to be a saving when worked out as above of 35 per cent. in favor of the tantalum lamp with the clear bulb with energy at 10 cents per unit. With the energy at 5 cents, the saving amounts to 31.5 per cent., and at 3 cents, to 13.5 per cent.

WATER, ICE AND STEAM MIXTURES

Some Pertinent Problems Connected with Jet and Surface Condensers

Water occurs in nature in three states, namely: solid, liquid and gaseous. When it is solid it is known as ice, and when it is gaseous it is known as steam. Under atmospheric pressure it remains a liquid between 32 degrees and 212 degrees Fahrenheit, but if the temperature is decreased below 32 degrees or increased above 212 degrees, there occurs in the water what is known as a change of state.

It is during these changes of state that there occurs a change of heat which is not recorded by the thermometer but which is of the utmost importance when calculating results of the mixture of water and ice together or the mixture of water and steam. The importance of being able to calculate what temperature a mixture of steam and water will be, is clearly illustrated in the problems of the jet condenser, injector, and in some forms of calorimeters.

In following out the transformation of one pound of ice into steam at atmospheric pressure, it will be noticed that the water has passed through its three states of solid, liquid and gas in the following manner: from ice at 32 degrees into water at 32 degrees, from water at 32 degrees to water at 212 degrees and from water at 212 degrees into steam at 212 degrees. At each change of state there must be given to the water an amount of heat which is not sensible to the thermometer, and which is called the latent heat. This heat is used in performing internal work of breaking up the particles of ice or water, so that it can be transformed into another state. To transform one pound of ice at 32 degrees into water at 32 degrees requires 144 heat units, which is known as the latent heat of ice, and to transform one pound of water from 212 degrees into steam at 212 degrees requires 966 heat units, which is known as the latent heat of evaporation at atmospheric pressure.

When a pound of steam at atmospheric pressure is changed to a pound of ice, exactly the same cycle of events must be gone through, except that the heat must be abstracted from the pound of water under consideration instead of being added to it. That is, a pound of steam will give up 966 heat units when being condensed at atmospheric pressure and a pound of water at 32 degrees will give out 144 heat units before it is all frozen.

Properties of Low Pressure Steam.

Vacuum by Gauge	Absolute Pressure	Temperature	Latent Head of Evaporation
Inches	Pounds	Degrees F.	Heat Units
29	.425	75	1061
28.5	.692	90	1051
28.0	.943	100	1044
27.5	1.115	107	1039
27.0	1.435	114	1034
26.5	1.682	120	1030
26.0	1.931	125	1027
25.5	2.235	130	1024
25.0	2.417	133	1021
24.5	2.671	138	1018
24.0	2.900	141	1015
23.5	3.136	143	1013
23.0	3.399	146	1012
22.5	3.564	148	1010
22.0	3.900	152	1008
21.5	4.085	154	1006
21.0	4.373	156	1004
20.5	4.562	158	1003
20.0	4.863	161	1001

Between the freezing point and the boiling point of water, for every pound of water which is raised one degree, one heat unit is required, so that if one pound of water is raised 180 degrees, 180 heat units are required. In the transformation, then, of one pound of ice into steam at 212 degrees, the number of heat units required will be $144 + 180 + 966 = 1290$ heat units.

When finding the temperature of any mixture, it must be remembered that a heat balance must always be maintained; that is, the amount of heat which a cold body absorbs must be equal to the amount of heat which the hotter body gives up. This can easiest be illustrated by taking one pound of water at 40 degrees and mixing it with one pound of water at 80 degrees. The result is two pounds of water at 60 degrees; that is, the cool water at 40 degrees has absorbed 20 heat units, while the hotter water at 80 degrees has given out 20 heat units. Suppose 10 pounds of water at 80 degrees were mixed with 5 pounds at 200 degrees; what would be the resulting temperature? The 10 pounds at 80 degrees would contain 800 heat units above zero and the 5 pounds at 200 degrees would contain 1000 heat units, so that the mixture of 15 pounds would contain 1800 heat units, in which case the temperature would be $1800 \div 15 = 120$ degrees.

The calculations become more complex when steam and water are mixed together, since the latent heat of the steam must be considered in the calculations. Take, for instance, the problem: "What will be the resulting temperature in a jet condenser, if 25 pounds of condensing water at 60 degrees are mixed with each pound of steam at atmospheric pressure?" The same heat balance must be obtained as referred to above, which can be clearly shown as follows:

Let W = weight of condensing water.
" w = weight of condensed steam.
" T = temperature of steam.
" t = temperature of condensing water.
" t' = temperature of mixture.
" H = latent heat of evaporation.

then

$$W(t' - t) = w(T - t') + w\ H$$

which shows that the amount of heat given to the condensing water is the same amount as that given up by the condensed steam. In the given problem, $W = 25$, $w = 1$, $T = 212$ degrees, $t = 60$ degrees, t' = temperature required and $H = 966$, the latent heat of evaporation, or,

$$25(t' - 60) = 212 - t' + 966$$
$$25\,t' - 1500 = 1178 - t'$$
$$26\,t' = 2678$$
$$t' = 103 \text{ degrees.}$$

which is the temperature of the mixture.

The above formula is useful in all condenser problems, since it shows the heat balance for all conditions, the values of T, the temperature of the steam, and H, the latent heat of evaporation being obtained from the steam table. The problem is often given this way: "How many pounds of condensing water are required for a 100 horse power engine, if the engine uses 25 pounds of water per horse power per hour, the vacuum being 26 inches and the temperature of the condensing water 60 degrees?" Referring to the accompanying table, it will be noted that the temperature of steam at 26 inches vacuum is 125 degrees and that the latent heat of evaporation above zero degrees is 1027 heat units. The quantities in the formula then become: $t' = 125$ degrees, $T = 125$ degrees, $t = 60$ degrees, $w = 2500$ pounds per hour and $H = 1027$ heat units.

Then, $W(125 - 60) = 2500 \times 1027$

$65\ W = 2{,}567{,}500$

$W = 39{,}500$ pounds per hour.

In the case of a calorimeter, this formula is used for finding the amount of moisture in the steam, as everything in the formula is known except the quality of the steam, which affects only the total latent heat in the formula, so that the calorimeter formula becomes, when the steam and condensing water mix

$$W(t' - t) = w(T - t') + w\,H\text{-}x$$

in which everything is known but x.

Taking up the problem of ice and water mixtures, suppose that 4 pounds of ice at 32 degrees are mixed with 12 pounds of water at 100 degrees and it is required to find the resultant temperature. The latent heat of one pound of ice is 144 heat units, so that if W = weight of ice, w = weight of water, t = temperature of water and t' = the temperature of the mixture, the formula becomes

$$4(144 + t' - 32) = 12(100 - t)$$
$$448 + 4t' = 1200 - 12t'$$
$$16t' = 752$$
$$t' = 47 \text{ degrees.}$$

If ice is at a lower temperature than 32 degrees, its specific heat must be considered. This specific heat is 0.5 approximately. Suppose that 6 pounds of ice at 20 degrees are mixed with one pound of steam at 5 pounds pressure, then heat required to raise the 6 pounds of ice to temperature t' would be $0.5(32 - 20) \times 6 \times 144 + 6(t' - 32)$ and the heat given out by one pound of steam is $955 + 228 - t'$. Since these two quantities must be equal to each other, they become

$$6 \times 0.5(32 - 20) + 6 \times 144 + 6(t' - 32) = 955 + 228 - t'$$
$$6 \times 6 + 6 \times 144 + 6t' - 192 = 1183 - t'$$
$$6t' + 708 = 1183 - t'$$
$$7t' = 475$$
$$\text{or, } t' = 68 \text{ degrees,}$$

which will be the temperature of the mixture after all the ice has melted.

The problem of the surface condenser is very similar to that of the jet condenser. For instance, if the injection water flows in at a temperature of 60 degrees and out at a temperature of 120 degrees, 60 heat units are absorbed per pound. Now suppose the terminal pressure in the cylinder to be 4 pounds absolute, and the temperature of the exhaust steam to be about 154 degrees and the latent heat 1006, so that it will require $1006 \times (154 - 120) = 1040$ heat units to condense each pound of steam. By dividing 1040 by 60, the number of pounds of condensing water can be obtained, or, $1040 \div 60 = 17.3$ pounds.

densing water can be obtained, or, $1040 \div 60 = 17.3$ pounds.

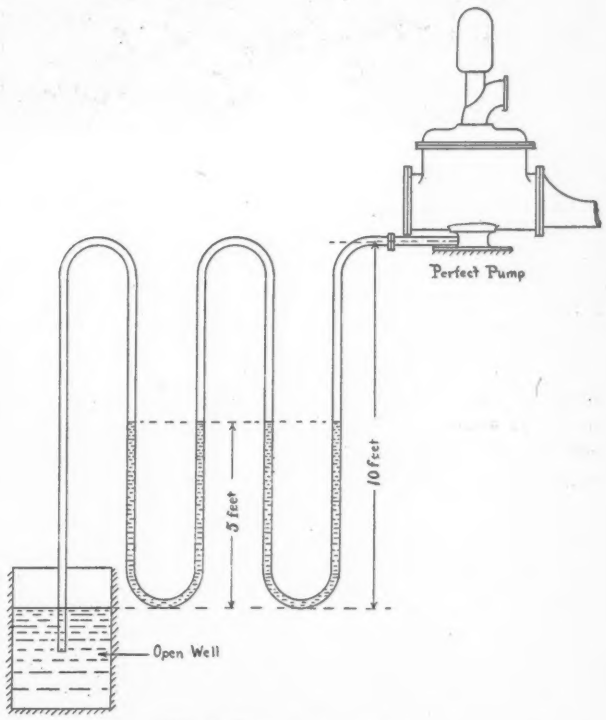
This result is obtained by using the above formula as follows:

$$W(120 - 60) = 154 - 120 + 1006$$
$$60\,w = 1040$$
$$w = 17.3 \text{ pounds.}$$

Keeping in mind that the heat absorbed must be equal to the heat given out, when mixing any substances together mechanically, many problems can be solved by this method. For very fine work, such as calorimetry, radiation and evaporation might alter the calculations, but for general condensing or other problems, the above formula will answer many questions.

An Interesting Problem. Will the Pump Draw Water?

About thirty persons were seated around the blackboard at an engineeers' meeting recently, when the problem illustrated in the accompanying sketch was brought up. The question was: "If a perfect pump is situated 10 feet above an open well, will the pump draw water out of the well with the pipe connections as shown? By a perfect pump is meant one that does not leak and there is water in the U-tubes standing to a height of 5 feet."



Will this Pump draw water?

In the discussion which followed, opinions were equally divided. Some engineers said it could not be done at all, while others said it was an every-day problem. Of the engineers who said it could be done, some said that it could be done theoretically but not practically, while others said that no theory could prove it, but it could be done practically.

The meeting adjourned without any definite decision and the question still remains: "Will the pump draw water?"

ELECTRICAL OPERATION IN PAPER MILLS

By A. Gradenwitz.

The introduction of electrical power transmission in the manufacture of paper has resulted in considerable improvement of the operation of paper-making machinery. In connection with these machines, two methods of operation are possible according as the number of revolutions is either constant or susceptible of control. The former plan is adopted in connection with the pulp strainer of the chain pump, etc., and can be effected by standard direct or rotary-current motors, while the other alternative is resorted to for operating the remaining machinery, beginning from the sieves. The following requirements have to be met with if this plan be chosen:

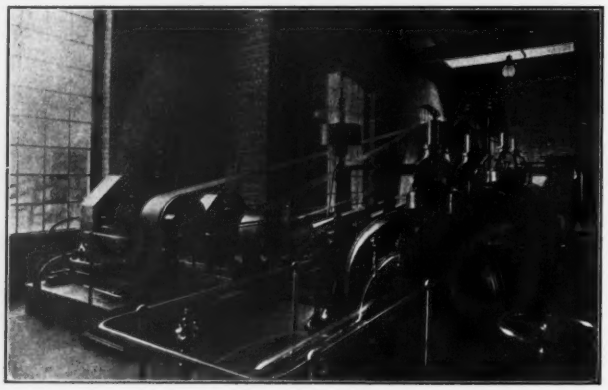


Fig. 1.—Generating Apparatus in Power House.

The number of revolutions should be susceptible of control in very wide limits, the starting torque should be very great and the variation of speed quite gradual and smooth from stoppage to the number of revolutions required, which is to be adjusted for with extreme accuracy and maintained unvariable, even with varying torques.

The number of revolutions at which the paper-making machine is worked is dependent on the thickness and quality of the paper. If accordingly the same machine has to serve the purpose of manufacturing different brands of paper, especially in small concerns, the speed should be susceptible of control up to the ratio 1 to 12. In larger paper mills, where special machines are provided for each kind of paper or where there is only a limited number of brands being manufactured, a variation in the ratio 1 to 4 will often be quite sufficient.

On account of the great number of bearings to be found in paper mills, the motor should exert a very high starting torque to overcome friction while at rest. The smoothness in the speed variation is required to avoid tearing the paper, while the number of revolutions is being adjusted for. The accuracy of adjustment is dependent on the quality of the paper to be manufactured.

The torque of the paper-making machinery will not vary during operation unless a roller having been wound on fully with paper, a new empty roller is to be inserted. Nevertheless, the number of revolutions once adjusted for should be kept as constant as possible during the relatively small oscillations of the torque, lest the paper be thinner with higher speeds and thicker with lower ones. Regulation in the main current and accordingly the use of rotary-current motors is therefore not practicable in most cases. The torque of the machine is, generally speaking, the greater as its speed is lower and the thickness of paper greater.

A regulation of the angular speed fulfilling the above conditions and working with great accuracy is readily obtained in connection with electric operation, when using a shunt motor with separate excitation of standard construction and the armature of which derives its current from a special starting dynamo which is likewise excited separately. The regulation of the angular speed is effected by varying the excitation of the starting dynamo, and accordingly, its armature tension and the angular speed of the driving motor from zero to the normal figures. Figs. 1 and 2 show an electrical plant installed on the above lines.

The primary station includes a dynamo that supplies the current to the armature of the motor driving the paper machine, as well as for starting this motor and controlling its speed. In addition to this, there is another standard dynamo supplying current to the remaining motors and for lighting, which, however, serves at the same time for the excitation of the starting dynamo and paper machine motor.

The paper machine motor is started while the regulation resistance of the starting dynamo is switched in entirely, so as to obtain the smallest tension of the latter, without requiring a special starting resistance. After being switched in, the motor will run smoothly and slowly.

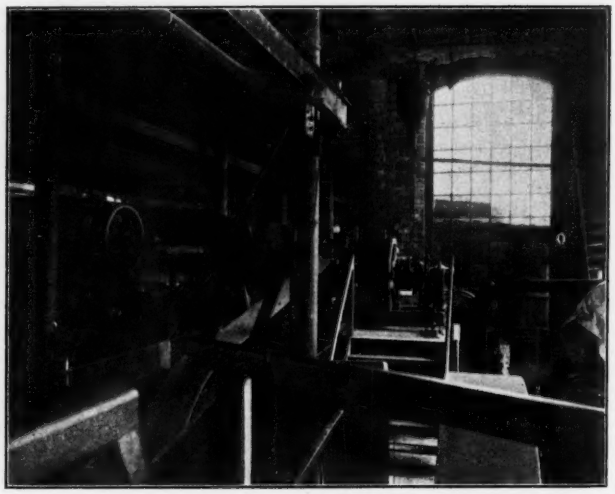


Fig. 2.—Electrically operated Paper-making Machinery.

By switching the regulation resistance gradually out of circuit, the number of revolutions is increased gradually up to the paper speed desired. The number of stages in the resistance upon which the accuracy of regulation is dependent can be taken as great as possible. In case the motor has to be stopped, the regulation resistance should again be switched in before interrupting the armature and exciter circuits.

The advantages of the arrangement outlined above can be briefly summarized as follows:

Both the first cost and cost of operation are low, as starting and regulating are not attended by any special losses. The number of turns once adjusted for remains constant even with greatly oscillating torques. The safety of operation is very high, there being only low currents in the regulation apparatus. Finally, the machine can be stopped readily and at a moment's notice by electrical braking.

Necessity the Mother of Invention in Many Rapidly Growing Plants.

By H. V. Schreiber

While it is of interest and profit to visit a nicely laid out plant, well cared for, it is sometimes a great revelation to know the conditions under which a plant may be run.

A recent visit to a water power electric plant which has both belted and direct-connected machines on four different floor levels has brought this to mind. On the top floor were six or eight Edison bipole dynamos of 200 kilowatt capacity each, belted to countershafts on the floor below, which in turn were driven by rope drives from turbines some sixty feet further down.

On the same floor level with the line shafts were two motor generator sets used to transform current received from another water power plant and through their own switchboard tying in with the Edison machines to carry a railway load.

Taking an elevator down to near the level of the tailrace revealed two 500 kilowatt direct connected units also connected on the railway load. Crawling under the coupling of one of these machines and up a narrow ladder, then through a dark doorway brought one to two other machines with their switchboards, transmitting power to the top floor level for distribution.

This whole plant is erected in a building which originally was a flour mill and illustrates how a plant added on from time to time will in the end, through its maze of belting, shafting, etc., become a constant risk to continuous service that no engineer could justify except under the spur of necessity, driven ever by the increasing load growing faster than the plant.

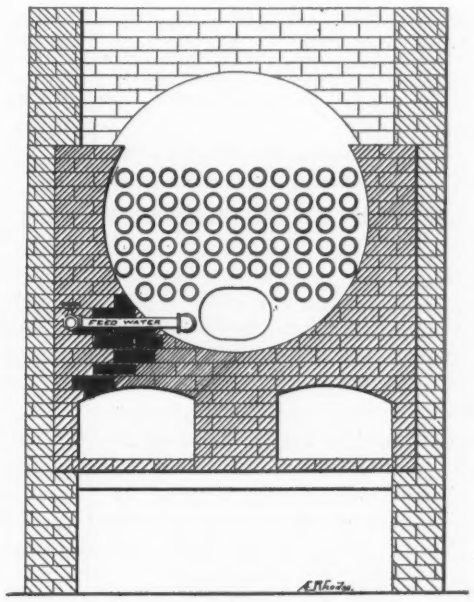
Another case in point is a turbine plant consisting of four 500 kilowatt units erected on four 2000 kilowatt unit foundations with no roof except boards to shed rain, which are nailed to the scaffolding which supported the piping and operating platforms. These turbines were borrowed to furnish power from a plant that could not even be staked out two and a half months before the current was turned on. The fact that this was done and that the plant is continuing in operation pending delivery of proper machinery speaks volumes for the "hustle" of the contracting company. At the time of writing, the auxiliaries and boiler plant are still open to the sky and doing business. The switchboard fared better, being in a separate building supported on a hastily-built concrete carpet, supported on the ends of piling driven into the swamp on which the whole plant is built.

While these 60 cycle alternating current and 500 volt direct current machines are running, it will be necessary to change the plant over to 40 cycles generated from new turbines and delivered to new rotaries in the various substations and at the same time put up a permanent building over the whole plant without interfering with the present operation. After the whole thing is installed it will be held as a reserve plant only, on account of a transmission from a distant water power plant which is being built to carry the regular load.

Boiler Foaming.

By A. E. Rhodes.

Did your boiler ever foam or give you any kind of trouble, the cause of which you could not locate, and then after months of patient trial, worry, and experimentation you find some simple explanation that makes you feel foolish? Recently my attention was called to a case of this kind, and I give it for the benefit of some one in a like fix. Not many miles from my native city there is a large manufacturing plant using some fifteen or more boilers of various kinds and sizes. The whole plant is under the supervision of a first-class chief-engineer, assisted by a corps of unusually competent engineers and firemen. One of the boilers at this place, after several years' faithful service, "went mad" and commenced to foam so badly that it was necessary to cut it out, and shut down that part of the plant until connection could be made with another unit of the power section.



Cause of Boiler Foaming.

The boiler was then examined, cleaned, and tested as any boiler would be under similar conditions, and upon firing up, the same trouble was experienced, but not to so great an extent as before. To cut a long story short, this boiler was very unsatisfactory for at least four months; then a more thorough examination revealed the fact that a few bricks in the front bridge wall had fallen out, thus exposing the feed water pipe to the direct heat of the furnace, as indicated by the black bricks in Fig. 1.

Since repairing the wall, no more trouble has been experienced. In justice to the engineering force at this plant, I want to say that the bricks fell out in such a way that it required a very thorough search to find that such is what really had happened.

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The Economical Use of Condensers.

It is generally taken for granted that when a plant is run condensing, there is an amount of coal saved equivalent to the degree of vacuum produced. This is often true but there are cases where a non-condensing plant will sometimes show a greater economy.

This is illustrated by the results of an investigation in England, which was based on the returns made by the various public and municipal lighting stations. In this investigation, two classes of power stations were considered, those that only supplied electric lighting to consumers and those that supplied a combined lighting and railway load.

In the case of the electric lighting plants, it was found that the non-condensing plants showed a much greater economy than the condensing plants, while the plants which had a combined lighting and power load showed a better economy when running condensing, but in both classes of plants, it was found that the partly condensing plants were the most economical, both in fuel consumed and works cost, the latter including fuel, oil, water, waste, stores, wages, repairs and maintenance.

Of the 22 stations investigated supplying light only, it was found that the cost of the fuel per kilowatt hour was 2.014 cents for non-condensing plants, 2.338 cents for condensing plants, while for partly condensing plants it was 1.944 cents. The works cost for the three kinds of plants also bore out the same ratio; 3.264 cents per kilowatt hour for non-condensing plants, 3.998 cents for full condensing stations and 3.152 cents for partly condensing stations. These figures are based upon the units sold to the consumer according to their meters and therefore include leakage and loss on the electrical mains, which may be as much as 20 per cent. in some cases.

These figures seem to indicate that with a lighting load, where the peak occurs for only about two or three hours in the evening, it is better to install a non-condensing plant, or, better still, to run the plant non-condensing during the hours when the current demand is light and run it condensing when the largest load is on the station.

While it is well understood that the condensation of exhaust steam itself should lead to higher economy, there must be some reason why the above plants did not use the value of condensation to its greatest extent. Among these losses may be mentioned the difference in vacuum between the low pressure cylinder and condenser, loss in starting up separate plants for short runs; the loss at light loads, and the loss of vacuum through leaky exhaust valves.

This means that with a condensing plant, greater care must be exercised in keeping everything up to best of condition, especially the valves of the engine. In electric generating engines, the maximum steam losses are mostly due to valve leakage and piston leakage, usually the former, and in condensing plants, using engines fitted with piston valves, heavy leakage is likely to occur without being noticed. In non-condensing engines, the exhaust pipe usually gives warning of leaky valves, but in the condenser, steam is likely to slip away without being noticed. Balanced slide valves or Corliss valves require less attention to keep them tight.

In the stations, which had a combined railway and lighting load, the condensing plant showed a greater economy than the non-condensing plant but the partly condensing plant showed a greater economy than both. This can probably be accounted for by the fact that up to a certain percentage of the output of the plant, the use of good feed water heaters and economizers is more economical on account of getting a hot boiler feed. The economy of works cost is also less because there is less capital invested in the non-condensing plant and the repairs are fewer.

In well-designed plants, however, where the cost of condensing water is not excessive, the best results should be obtained by running the engines condensing, but this necessitates keeping all parts of the plant in the best condition and it does not do to assume that the words condensing and economy are synonymous.

Experiences.

While it is generally true that one cannot get too much experience in any occupation or walk of life, it is particularly true along the line of engineering. A man who has devoted his life to engineering will often be "up against it" to account for many of the peculiar happenings around his plant but how much more so is a man puzzled who has had no experience to guide him.

This is illustrated by some of the reminiscences of Mr. Felix McCarthy, superintendent of the Warwick Iron and Steel Company, who has had varied experiences in engineering for many years. On one occasion he was engineer of a steam boat running on Lake Champlain. The boat had two boiler feed pumps which were situated about three feet above the hot well. The suction pipes were about 4 inches in diameter and were not

provided with foot valves. The steam cylinders of the pumps were scored pretty badly, so that they were treated with a large amount of graphite to fill up the scored places. A long time after this it was noticed that about every five or six hours, one of the pumps would not draw water. The pump was stopped, the water cylinders and valves were gone over carefully but nothing wrong could be found. It was not long after this that pump No. 2 did exactly the same thing and when that pump was examined everything appeared in fine shape.

When the pumps were started up they worked satisfactorily, but in five hours one of them would stop pumping. This pump would then be shut down and the other one started up, but in about the same length of time that pump would no longer draw water, when the first pump would be started again. Things went along this way and by starting the one pump when the other stopped, enough feed could be supplied to the boiler.

During this time it was noticed that the time between the starting up of the different pumps was gradually becoming shorter until finally each pump would only draw water for about an hour. The boat was in the middle of the lake, the captain was yelling down the tube to make time and as the boilers needed all the water that was being pumped, it was not an enviable position to be in.

The boat finally made port and the first thing examined was the hot well and the suction pipes. The cause of the trouble was then discovered. In the suction pipe of the pump last used, there was found a ball of graphite and dirt, just sufficient to stop up the pipe. This had evidently been getting larger and larger, so that while at first it only partially stopped the suction pipe, it finally became so large that it stopped the suction of the pump altogether. When the pump was stopped, the ball of dirt would dislodge itself from the one pipe, and the suction of the other pipe would draw it over and stop the suction of that pump.

While this experience may seem trivial to some of us, yet it is just such things that are continually arising to confront the engineer and make him scratch his head.

The Difficulties of Hydraulic Engineering.

When any branch of engineering is in its infancy, the divergence between practice and theory is usually the greatest but as theory points its warning finger in a certain direction, practice usually conforms, although perhaps reluctantly, to its dictates. That is, while for various reasons, it may seem better to build a piece of machinery in a certain manner, yet certain laws of science or engineering may prove conclusively that some other way would be better, or perhaps, practice will show that many things indicated by theory will have to be modified. And so the pendulum swings back and forth until its amplitude becomes less and less and there is a fixed law for doing things which is generally adopted and adhered to by all.

The most recent and conclusive evidences of this can be shown in the building of the electrical generator. It has not been many years ago that scores of different types of machines were built to answer the same purpose and designs used widely different methods to attain the same results. Practice and theory joined hands so well that all manufacturers of electrical machinery now use the same basic rules and any difference in design is more optical than anything else. Thus, one of our younger branches of engineering is now followed with more or less cut-and-dried rules and were it not for the introduction of the alternating current, which involves the complex relations of capacity and self-induction, most problems pertaining to electrical distribution could be solved by a simple equation.

On the other hand, a branch of engineering which is one of the oldest, is that of hydraulics, but today there is as much uncertainty pertaining to its practice as there was a generation ago. One reason for this is that, while in other branches many of the formula used have a firm experimental foundation, yet in hydraulics there are so many variables encountered that the results obtained in one experiment cannot be applied in another which may appear similar. For instance, the flow of water and coefficient of discharge obtained from a rough timber flume cannot be applied to a large pipe or perhaps another similar flume without making some error. For these reasons, the calculations of the flow in canals, flumes and pipes are still subject to much error and there are very few hydraulic plants which have not encountered them. One of the testing flumes in New England, which was thought to be a standard for a number of years, was found to contain errors in design which altered the true flow of water through it. The failure of dams built by engineers of the highest reputation who made their calculations with what they thought was a high factor of safety, is another indication of the difficulty of hydraulic engineering.

Inventor of the Shive Governor Dead.

David Shive, inventor of the Shive governor, died at his home in Philadelphia, on August 28th, having attained the age of eighty-seven years. He was not only the inventor of the governor which bears his name, but he also invented many other mechanical appliances. For a long time he manufactured the governors at Bethlehem, Pa., and he made and lost fortunes on his patents. He was the winner of gold medals at several centennials. His governor, which was used on throttling engines, was widely known in the earlier days of steam engineering.

Lime Mortar for Boiler Setting.

When lime mortar is used in a boiler setting, it should be allowed to stand as long as possible between the time of slacking and using in the wall. When freshly slacked lime is used in a boiler setting, the unslacked particles in the mortar finally swell, making the mortar loose, so that the brickwork is usually a failure. Lime for boiler setting should be slacked at least six weeks, or longer, if possible, before using.

Aluminium conductors are employed on the largest electrical transmission lines in this country. On the longest line, that from the Electra power house to San Francisco, a distance of 154 miles, aluminium is the only conductor used. The 144-mile transmission between Colgate and Oakland consists of three aluminium and three copper wires and on the transmission lines from Shawinigan Falls to Montreal, a distance of 85 miles, three aluminium wires are used to carry the high-tension current.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Rules for Finding the Number of Field Poles, Frequency and Speed of Alternators.

EDITOR THE PRACTICAL ENGINEER:

Having given an engineer recently some information about alternators, I think the following rules for determining the number of poles, frequency and revolutions per minute of an alternator might be of interest to your readers.

Let us assume that it is desired to find the proper number of field poles for an alternator having a frequency of 60 cycles and making 150 revolutions per minute. The formula for finding this is

$$P = \frac{2FS}{R}$$

where P = number of poles, F = frequency, S = number of seconds in one minute and R = revolutions per minute. In the given problem, F = 60, S = 60 and R = 150, so that

$$P = \frac{2 \times 60 \times 60}{150} = 48 \text{ poles.}$$

For determining the speed in revolutions per minute, the formula becomes

$$R = \frac{2FS}{P}$$

and for determining the frequency, the formula becomes

$$F = \frac{PR}{2S}$$

If in the given problem everything is known but F, by substituting the number of poles and revolutions per minute, we have

$$F = \frac{48 \times 150}{2 \times 60} = 60 \text{ cycles.}$$

The rules are then as follows:

To find the proper number of poles for an alternator, multiply twice the frequency by 60 seconds and divide the product by number of revolutions per minute, or divide twice the frequency by the number of revolutions per second.

To find the speed of an alternator, in revolutions per minute, multiply twice the frequency by 60 seconds and divide the product by the number of poles, or divide twice the frequency by the number of poles and multiply by 60 seconds.

To find the frequency of an alternator, multiply one-half the number of poles by the revolutions per minute and divide the product by 60 seconds, or multiply one-half the number of poles by the revolutions per second.

The above formulæ and rules are applicable to synchronous motors, as synchronous motors have the same general construction as alternators. If an alternator is supplied with alternating current, it will operate as a synchronous motor and deliver mechanical power at its pulley, and vice versa. Of course, in either case, the field must be excited by continuous current.

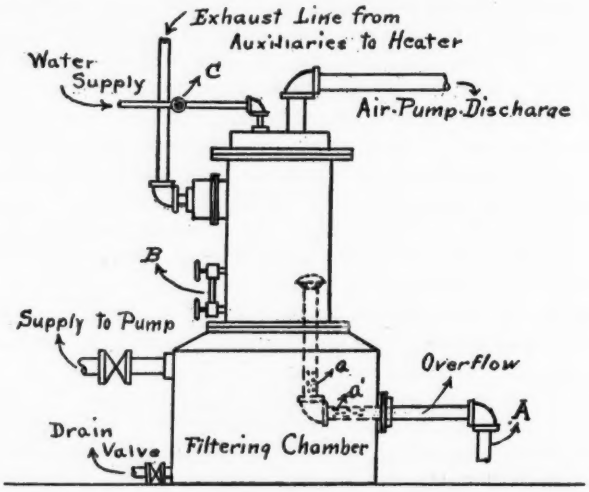
An alternator will only operate as a synchronous motor when supplied with a current of the same phase that it generates when running as an alternator; that is to say, a three-phase alternator will not run as a synchronous motor if supplied with a single-phase or a two-phase current, but must be supplied with a three-phase current.

A. C. KELLY.

Pitted Over-flow Pipe in Heater.

EDITOR THE PRACTICAL ENGINEER:

When I got home from my work, the other evening, an engineer friend of mine was there waiting for me. He said that he was having some trouble with his heater and that there was also a kick from the office about the unusually large amount of water that he had used during the past two months. The fellow seemed much worried, and I agreed to go the next day, which was Sunday, to see if I could locate the trouble.



Feed Water Heater showing Pitted Pipe.

I was soon carefully examining each possible cause of any trouble; I first disconnected the piping from the drain leading to the sewer, and found the valve in good shape and tight; I then disconnected the overflow pipe at A, then I opened the water supply valve at C, wide open. In a short time the water showed in the glass at B, but as soon as the supply valve was shut, the water dropped out of sight. This led me to think that there was something wrong with the overflow pipe in the base of the heater. Well, after an hour's hard work taking off the clean-out door to the filtering chamber, and cleaning out the coke, we discovered that the piping, as shown at a and a' in the accompanying sketch, was very badly perforated by pitting and through these perforations is where all the extra water was going, and it was no wonder that he could not get the water up to the proper temperature to feed to the boilers. It only took a day or so to replace the piping, that had been eaten by pitting, with new galvanized hydraulic pipe.

There is no complaint now of waste of water, and much less fuel is being used. The engineer stated that the heater had been in use only about three years, and as he thought it was to purify the water, he never even dreamed that the water passing through it would eat it out in that way.

Depew, N. Y. C. W. D.

How Engineers are Examined in Massachusetts.

EDITOR THE PRACTICAL ENGINEER:

As is well known, Massachusetts has as rigid and satisfactory a license law as there is in this country, so that it may be of interest to readers of this paper to hear something of the equipment and character of the examinations.

In the examination plant at the State House, Boston, the equipment consists of a small horizontal return tubular boiler with many necessary and unnecessary fittings piped up to serve for both low pressure heating and high pressure power work. It has connections to all apparatus in the plant, the same as outside jobs. One side of the setting is cut away to show the interior of the furnace, combustion chamber, back connection and the setting of the boiler. The feed pump, injector and heater are piped up in various ways. There are several parts and fittings of engines, pumps and tools for repair work in plants; a slide valve, riding cut-off valve and a Corliss engine for valve setting. Of course, there is no pressure in the system.

An applicant is given a careful, thorough and fair examination, commencing with simple problems and advancing through various branches. The higher the grade license is wanted, the more severe the examination, which consists of the proper and improper handling of plants and the results likely to occur under certain circumstances, and the general safety and economical handling of plants generally.

The following are a few of the many questions asked an applicant for a license:

1. Draw the theoretical cards of a compound engine whose high pressure cylinder is 25 inches in diameter, low pressure 50 inches, stroke, 36 inches, revolutions per minute 165, steam pressure 135 pounds and vacuum 22 inches. Give and figure out in detail the initial, terminal and compression pressures, points of cut-off on both cards, thermal and mechanical efficiency and steam consumption from the cards.

2. Of what benefit is a vacuum breaker on a condenser taking injection under a head or pressure?

3. What size feed pipe is necessary to properly supply a 72-inch boiler? Explain in detail.

4. What parts of a water-tube boiler are subjected to the greatest strains when working, and why?

5. Why are the tubes in a water-tube boiler inclined?

6. A 66-inch boiler has a 10" x 14" manhole cut in the sheet; figure out the proper size reinforcing ring to make up strength taken away.

7. Figure the strength imparted to a 72-inch boiler head, 5/8-inch thick, by a 5/8-inch channel iron, steam pressure 125 pounds.

8. By adding a condenser, how much can boiler pressure be reduced so as to keep the same cut-off and mean effective pressure?

9. Are there any advantages in equipping a boiler with two small safety valves, in place of one of the same area?

10. What is the effect on an engine when the exhaust valve leaks?

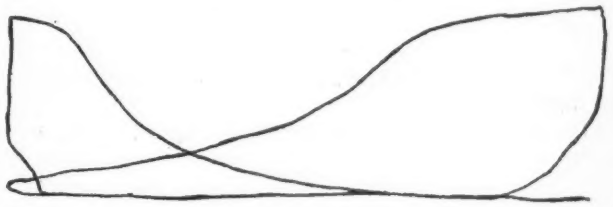
Of the above questions, I admit that questions 1, 3 and 6 were too much for me and I would like to have some engineers answer them for me.

Lawrence, Mass. A. W. B. E.

Racing Engine Caused by Poorly Set Valves.

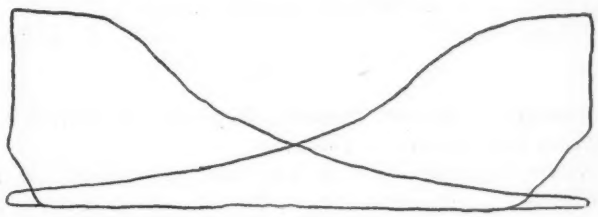
EDITOR THE PRACTICAL ENGINEER:

A brother-engineer had trouble for two years with a 14 x 24 engine because it raced. The blame was, of course, put on the governor. When part of the load was thrown off, the engine



Card No. 1.—Card taken when Engine was Racing.

would race and the steam would have to be throttled to keep the engine running at its regular speed. I stopped at this plant, one day, and looked the governor over but could see nothing wrong with it. I then applied the indicator and got card No. 1. The conclusion I came to was that if the valves were adjusted properly, the racing would be over with. I adjusted the valves and the racing was stopped. The engine now runs with the minimum or maximum load with a wide-



Card No. 2.—Card taken after adjusting Valves which cured racing.

open throttle. Card No. 2 is the card which it now gives. This is another illustration to show the value of the indicator.

Danbury, Conn. J. M.

Boiler Head Bracing.

EDITOR THE PRACTICAL ENGINEER:

While reading over your journal, I have noticed many requests from engineers for rules determining the number of braces, size and allowable stress for bracing boiler heads. All the instruction I have seen so far has been good, but as we all have various methods for doing the same things, I will present my formula for finding the area to be braced, and apply it to a boiler of ordinary size with the required thickness of shell and heads. This method has been found to give results corresponding very closely to the specific requirements of the boiler inspection and insurance rules.

It is first necessary to find the height of the surface to be braced. This is done by measuring equal distances between

the two outside tubes at the top of the top row at the head; then measure from the centre of this distance to the top of the shell and this will give the height of the segment of a circle, as it is called.

To take a specific example: Our boiler is to be 60 inches in diameter and the height of segment to be braced is 15 inches, as shown in sketch. Then, if A = area of segment, h = height of segment and D = diameter of boiler,

$$A = \frac{4\,h^2 \sqrt{D}}{3\sqrt{h}} - .608$$

Substituting 15 inches for h, and 60 inches for D, we have

$$A = \frac{4 \times 15 \times 15 \times \sqrt{60}}{.3 \times \sqrt{15}} - .608$$

or,

A = 599.39 square inches for which braces are required.

The solution of the above is as follows: $\frac{(4 \times 15 \times 15)}{3} = 300$

and the square root of 60 divided by the square root of 15 is equal to the square root of 4, which is equal to 2. The formula then becomes: $300 \times 2 - .608 = 600 - .608 = 599.39$ square inches. Allowing a pressure of 100 pounds per square inch, the total pressure will be 59,939 pounds.

The usual allowable stress on a brace is 6000 pounds per square inch; then $59{,}939 \div 6000 = 9.98$ or 10 square inches are required. This would be equivalent to 10 1¼-inch bolts or ten ½-inch x 3-inch bolts, if flat; that is, the sum of the areas of the bolts must be ten inches. This formula allows for the wasting away of the iron by corrosion. The surface below the tubes can be calculated in the same manner.

Clinton, Iowa. L. A. H.

Economical Receiver Pressure. Depends upon Governor.

EDITOR THE PRACTICAL ENGINEER:

In the September issue of "The Practical Engineer," E. P., of Redlands, Cal., asks what receiver pressure to carry on his engine.

With one-fifth cut-off and initial pressure 150 lbs. gauge, or 165 absolute, the terminal pressure in the high pressure cylinder will be $165 \div 5 = 33$ pounds absolute or 18 pounds gauge which theoretically would be the receiver pressure, but owing to the fact that there is more or less expansion and condensation going on in the receiver, the receiver pressure would probably not be over 12 or 14 pounds.

Whether this would be the most economical pressure to carry depends on conditions. The highest plane that the governor will ride in and still maintain the speed and carry the load is the most economical way to run an engine. Following out the above rule, the receiver pressure should be adjusted so as to allow the governor to ride in the highest plane regardless of whether each cylinder does the same amount of work or not.

The fact that both cylinders are doing the same amount of work does not necessarily mean that the engine is running the most economical way. For instance: I have in mind a 28" x 52" x 60" engine, 140 pounds gauge pressure and condensing to 25 inches, cutting off at a trifle less than one-fifth stroke, with 5.4 expansions. The terminal pressure in the high pressure cylinder will be $155 \div 5.4 = 28.7$ pounds absolute, providing expansion was carried to the end of the stroke but as the exhaust opens a little before the end of the stroke, the pressure would be a trifle greater. On the actual card taken from the engine it is 31 pounds absolute or 16 pounds gauge. When carrying full load, the receiver pressure is only 8 pounds gauge, as it was found to be the most economical pressure to carry.

Under the latter condition, the mean effective pressure in the high pressure cylinder is 48 pounds and in the low pressure 10.2 pounds, which gives 542.4 horse power for the high and 397.8 horse power for the low, or 144.6 horse power more work done by the high pressure cylinder than by the low pressure cylinder.

If the receiver pressure was raised to make the low pressure cylinder do the same work as the high pressure cylinder, it was found that the governor rode lower, showing that it was not so economical.

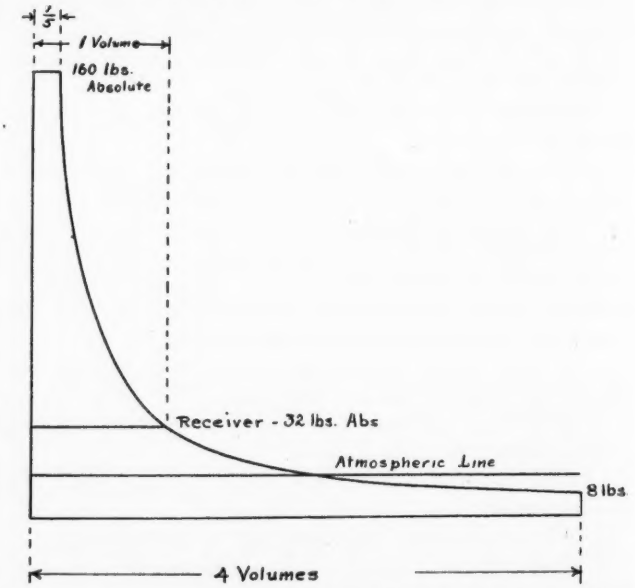
New Bedford, Mass. F. W. C.

Receiver Pressure.

EDITOR THE PRACTICAL ENGINEER:

I beg to add a few words to your answer to E. P., Redlands, Cal., in the September issue, about receiver pressures.

From the information E. P. gives it is clear that his engine is a condensing engine. The ratio of cylinders being four, a cut-off of one-fifth in the high pressure cylinder gives a total ratio of expansion of 20. This reduces the low pressure terminal pressure to 8 pounds absolute. The accompanying diagram correctly represents the conditions.



Receiver Pressure for a Compound Engine whose Cylinder Ratio is 4, Initial Pressure 160 pounds, Cut-off 1-5th stroke

The greatest power is obtained by adjusting the low pressure cut-off so that there is no drop at the end of the high pressure stroke. The corresponding receiver pressure is $160 \div 5 = 32$ pounds absolute. This is the maximum receiver pressure that should be allowed and in practice 15 pounds gauge pressure would be about right.

The receiver pressure is governed by the low pressure cut-

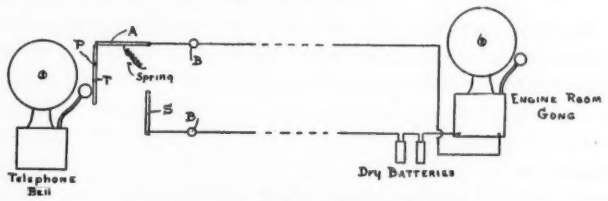
off; cutting off earlier in the low pressure cylinder will raise the receiver pressure, cutting off later will lower it.

T. F. N.

Device for Engine Room Telephones.

EDITOR THE PRACTICAL ENGINEER:

I have noticed some little devices and kinks in your paper, especially in the July and August numbers, which I think are of great help to engineers in small plants where the engineer has to put up with what his employer wants to get or else make these devices himself. I will illustrate a little attachment for a gong signal which I use and it may help some engineer out who is in the same fix that I was.



Connections for Engine Room Telephones.

A telephone is required in our plant but the engine room and boiler room are noisy on account of the mechanical draft that is kept running, so my partner-engineer and myself fixed up this little device, which is always reliable. We placed our telephone in an adjoining room where it was quiet and put the gong and two dry batteries in boiler room. We attached it to the telephone as follows:

BB are any two binding posts, T is a trigger pivoted at P, A is a piece of steel pivoted so that the spring can draw it down to touch the contact S. The dry batteries and gong in the boiler room are connected in series to binding posts B, B.

When the bell on the telephone rings, the clapper releases arm A, which is drawn down to make contact with S. This creates a circuit and makes the gong ring in boiler room. When answering your call, set your trip and it will be ready for another call. This attachment is one of the simplest I have run across and can be relied upon at all times.

Bellefontaine, Pa. M. C. R.

Tubes and Flues.

EDITOR THE PRACTICAL ENGINEER:

While reading letters from engineers, I have often noticed that they use the words "tubes" and "flues" in connection with steam boilers, as if they meant the same thing, but the letter of C. C. B., in the September issue, has reached the limit, and I wish to call attention to the fact that in writing so carelessly, he not only misapplies the words, but contradicts himself.

A tube is 4 inches or less in diameter. A flue is more than 4 inches in diameter. Let us all discontinue the careless and inconsistent use of these words.

New Haven, Conn. W. H. WAKEMAN.

Why Did this Engine Drop Dead?

EDITOR THE PRACTICAL ENGINEER:

I have seen a little trouble with an upright Allen engine which was very peculiar. The engine has cylinders 8 and 10 inches in diameter and 14 inches stroke. It was running 360 revolutions per minute with 90 pounds steam pressure and a load of 65 amperes at 110 volts, when suddenly it stopped dead. The engineer shut off steam immediately and examined it all over but found nothing wrong; no hot journals or anything. So he pulled his switches and started her again and she has been running fine ever since. He also examined all wires but found nothing wrong. I have asked a great many engineers, but they cannot give any explanation, as it puzzles everybody to explain why it stopped so suddenly without breaking anything, so I thought that this might interest your readers and perhaps some one can solve it.

Montreal, Canada. S. J. L.

Handy Fire-room Tools.

EDITOR THE PRACTICAL ENGINEER:

Very many boilers are so constructed that only one of the furnace doors is opened at one time while cleaning fires, owing to the partition separating them, as shown in Fig. 1. When both doors are open, it is usual to put the lazy bar on top of the hinges of both doors, but with only one door open, some other arrangement must be used. The writer has done this by securing to the bolt of the door-frame a piece of iron ¼-inch thick by 1½-inches in width, as shown in Fig. 3. This holds one end of the lazy bar and is allowed to remain in its fixed position. The lazy bar is made of ¾-inch iron, as shown in Fig. 2. It is shown in place in Fig. 1.

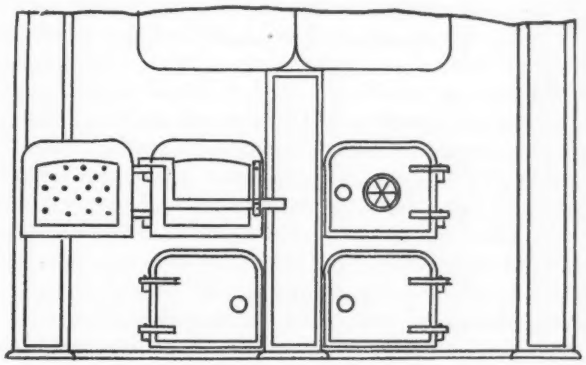


Fig. 1.

Where the writer is employed, No. 2 buckwheat coal is used and a hoe was made suited to that grade of coal by using a piece of iron $^{5}/_{16}$-inch thick by 6½-inches wide and 13 inches long, as shown in Fig. 4. A ¾-inch pipe the required length was threaded on both ends and made up the same as in Fig. 6,

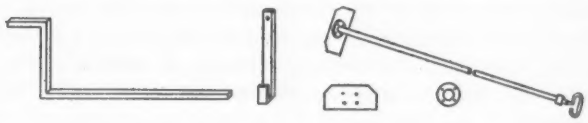


Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

with a reducing coupling and a piece of iron threaded to fit coupling and shaped oval to fit the hand, the pipe being connected to the blade of the hoe with a flange, as shown in Fig. 5. This makes a very substantial hoe, which is light and can easily be repaired.

Brooklyn, N. Y. J. G. S.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Horse Power Required to Pump Water. Lap and Compression. Starting an Old Plant.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions:

(1). What horse power is required to raise 500 cubic feet of water against 100 pounds pressure with a 25-foot lift?

(2). What effect does inside lap and outside lap have on an engine?

(3). How would you start up a plant that had been shut down for an indefinite length of time?

(4). How would you start up a plant that had been shut down for a short length of time?

(5). What is compression and what effect does it have on an engine?

Blanchester, O. G. W. G.

(1). The thing to do in problems of this kind is to find the number of pounds of water which must be lifted; then find the number of feet through which the water must be lifted and then the time required to do it. In this problem, the number of pounds of water to be lifted is $500 \times 62.5 = 31250$ pounds, since one cubic foot of water weighs 62.5 pounds. One hundred pounds pressure is equivalent to 230.4 feet, since one pound pressure is equal to 2.304 feet head and since the lift is 25 feet, the total head is 255.4 feet. The number of foot pounds of work is the product of 31250 and 255.4, which equals 7,982,250 foot pounds. The time in which this work is to be done is not given in the problem, but assuming that it must be in one hour, the horse power required is $7,982,250 \div (33,000 \times 60) = 4.03$ horse power. If the 500 cubic feet of water must be lifted in one minute, then the horse power required would be 241.9.

(2). The effect of outside lap, or steam lap, is to make admission later and cut-off earlier and lessens the lead of the engine, if the angular advance and eccentricity of the engine are not changed. The effect of inside or exhaust lap is to make the exhaust valve open later and compression begin earlier.

(3-4). In answering these questions, it is almost easier to tell what should not be done than what should be done. Undoubtedly, one of the first things to be done in a plant which has not run for a long period is to inspect the boiler inside and out. Perhaps the better way would be to call in some insurance inspector and get him to certify to the condition of the boiler and ask him what would be necessary before he would insure it for a given pressure. After being assured that the boiler is in condition to run, the feed pump should be examined and repaired, if necessary; all pipes leading to the boiler should be disconnected and examined; all flange joints should be taken apart and re-made; the water column should be taken apart and examined; the steam gauge and safety valve should be inspected and tested and the blow-off valve and pipe inspected. After everything pertaining to the safety of the boiler has been examined, the boiler should be filled with water to the running level and a very slow fire started. The condition of the setting and the draught can then be noted, and if these appear satisfactory, then pressure can be raised gradually. The injector can then be tested and the feed pump and other auxiliary apparatus should be made to work at their best.

Attention can then be turned to the engine room. The foundation and foundation bolts of the engine should be examined; the fly-wheel should be trued up; governor should be eased up; valves should be set; cylinder rebored, if necessary; new packing put in wherever required; bearing scraped or rebabbitted; oil cups and oil channels cleaned and many other things depending upon the character and size of the plant.

The quantity and kind of supplies on hand should be noted and a supply of packing, oils and other things needed should be kept on hand. If the proper engine room tools are not at hand, they should be ordered, the first thought, however, being only to get those which are necessary to prevent any shut-down. After the plant has started to run, an experienced engineer will soon know what is required and what changes in the plant will have to be made, all of which should be carefully noted and at the first shut-down, these should be attended to. These are only a few suggestions, but from the above, it can easily be seen how it is impossible to give all details.

(5). When the exhaust valve of an engine closes before the end of the stroke, it encloses in the cylinder a small quantity of steam which is compressed as the engine reaches the dead-point. This is known as compression and serves several purposes: one is to bring the piston more easily to rest and start it off on its new stroke without any jar, and another is to economize steam, which it does by saving that quantity of steam each stroke, which is retained in the cylinder after the exhaust valve closes. Without compression, the clearance spaces have to be filled each stroke with live steam from the boiler.—[Ed.]

How Lap Can be Changed.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following question:

If you had a plain slide valve with ⅛-inch lead at each end, can you set it so that you will have ⅛-inch lead at one end and $^3/_{16}$-inch at the other? If so, how would you do it and, if not, why not?

Mingo Junc., Ohio. D. T.

Lead on one end of a slide valve can only be changed by changing the lap. Increasing the lap decreases the lead and decreasing the lap increases the lead, with a given eccentricity and angular advance.

One method for doing it would be to change the dead centre of the valve by moving it on the rod, in which case the lap would be increased on one end and decreased on the other.

In the given case, since the lead on one end must remain the same and that of the other end must be changed, it would be best to remove $^1/_{16}$-inch of the lap from the end, which requires the $^3/_{16}$-inch lead and leaves everything else the same as it was originally.

Care must be taken that this does not distort the other events of steam distribution, since decreasing the lap increases the lead, makes admission earlier and cut-off later.—[Ed.]

Setting Valves on the Greene Engine.

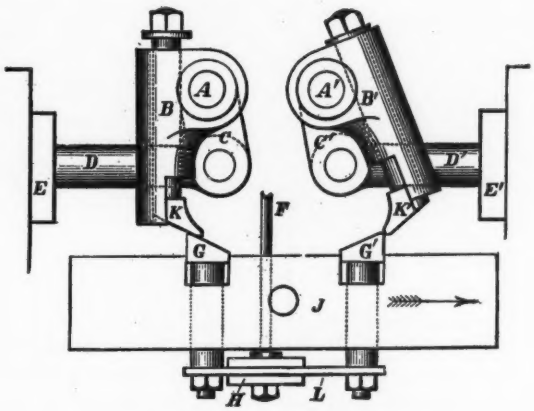
EDITOR THE PRACTICAL ENGINEER:

Please put in "The Practical Engineer" a method for setting the valves on the Greene engine.

Cambridge, Mass. F. L.

The Greene engine belongs to the four valve type of engine, in which a slide valve is used in place of the Corliss valve. There are two steam and two exhaust valves. The steam valves are moved by an arrangement shown in the accompanying illustration. AA′ are two rock levers; BB′ the sockets attached to them and within which the toes KK′ are contained; CC′ are the arms of the levers attached to the valve stems; DD′ are the valve stems; EE′ the steam chest; F the governor rod; GG′ the tappets; L the gauge plate; H the gauge plate guide and J the sliding bar.

The exhaust valve receives its motion from a side shaft which is moved by the exhaust eccentric. The outer end of the exhaust steam valve is connected to a small crosshead which is slid backward and forward by a toggle joint. The toggle joint, in straightening out, opens the exhaust valve and when bending together, closes it.



Valve Gear on Greene Engine.

When setting the valves, remove the covers from the steam-chest and exhaust-valve chamber. Loosen both eccentrics from the shaft and see that the valves move equally over the ports. If not, they must be made to do so by adjusting the eccentric rods to the proper length. This can best be done by moving the steam eccentric around on the shaft from one dead centre to the other and if the ports are not open an equal amount and one valve is found to open the port as much too wide as the other fails to open it, the trouble may be removed by adjusting the length of the eccentric rod.

If the valves fail to open a sufficient amount, the trouble may be found in either the length of the valve stem or the height to which the toes GG′ have been raised by the governor. If by adjusting the toes, one of the valves is still found not to open properly, the valve must be moved on the valve-stem until it does.

The travel of the exhaust valve is ascertained in the same manner by moving the exhaust eccentric from one dead centre to the other and if the valve does open and close the port at the proper intervals, the trouble may be corrected by first adjusting the link which connects the exhaust valve with the side-shaft and then adjusting the length of the eccentric rod.

Having the eccentric rods adjusted to their proper length so as to get an equal distribution of steam and exhaust on both ends, the eccentrics are ready to be set. Place the crank on the dead centre nearest the cylinder and the full side of the steam eccentric the same. Then move the eccentric in the opposite direction to that in which the engine is to run until the valve at the head end opens the port to the amount of the lead, which should not exceed $^1/_{32}$-inch. Fix the eccentric to the shaft at this point. Then turn the engine to the opposite dead centre, when the valve on the crank-end should have opened the port an equal amount. If the lead is not the same on both ends, it may be due to the wear on the toes KK′ in which case it can be adjusted by moving the eccentric slightly or by moving the valve on the valve-stem.

When the engine is running, the governor regulates the point of cut-off by moving the gauge plate, L, up and down. The tappets in the sliding bar, GG′ are attached to the gauge plate and are elevated or depressd in the bar, J, by the action of the governor. As the sliding bar moves in the direction of the arrow, shown in the accompanying drawing, one of the tappets is brought into contact with the inner face of the toe on the rock lever, causing it to turn on its axis, thereby opening the steam valve at one end of the cylinder. At the same moment the other tappet comes into contact with the outer face of the other toe, and as the surfaces are bevelled, the toe is forced up into its socket until the tappet passes under, when it drops by gravity into its original position, so that it can be operated on when the sliding bar is reversed.

If, then, the valves are set properly to begin with, the tappets always give the valves the same lead, and as the bar moves in a straight line, while the toe describes an arc of a circle, the tappet will pass by and liberate the toe, which thus closes the valve and cuts off the steam. The liberation of the toe takes place sooner or later, according to the elevation of the tappets. The lower the tappets are, the sooner the toes will be liberated and by the elevation or depression of the gauge plate, the period of closing the valves is changed, while the period of opening them remains the same.

It would be well, however, before replacing the steam-chest cover, to try the points of cut-off to be sure that they occur at equal distances in the stroke. To do this, raise the governor to about its normal working position and block it. Then turn the crank in the direction it is to run until one of the steam valves is released. Measure the distance the crosshead has moved from the end of its stroke and lay off the same distance on the other end of the guide. Turn the crank in the same direction as before, past the centre, and when the crosshead reaches the mark on the other end of the guide cut-off should take place. If it does not, then the tappets GG′ should be regulated so that cut-off does take place, when the crosshead reaches the mark on the other end. This should be tried

for different positions of the governor and if found correct, the steam covers can then be replaced.

To adjust the exhaust valves, first measure off a distance from each end, usually about 3 inches, and make a line on the guide. Turn the crank in the direction it is to run until the crosshead reaches one of the lines on the guide. Then turn the eccentric in the direction it is to run until the exhaust valve just closes the port. Fix the eccentric on the shaft and turn the engine over in the same direction until the crosshead reaches the line at the opposite end of the guide, when the opposite exhaust valve should have just closed the port. If it does not, it can be made to do so by adjusting the adjustable link. The exhaust steam-chest covers can then be replaced and the engine is ready to run.—[Ed.]

Efficiency of Triple-Riveted Butt-Strap Joint.

EDITOR THE PRACTICAL ENGINEER:

Please give a simple rule for finding the per cent. efficiency of triple-riveted butt-strap joints.

Boston, Mass. W. T. A. F.

The strength of a triple-riveted butt-strap joint may be calculated as follows: Suppose the thickness of the plates to be ⅝-inch, diameter of rivet holes one inch, and pitch of rivets 7¼-inches. By an examination of this style of joint, shown in the accompanying figure, it will be seen that one rivet is in single shear and four rivets are in double shear.

The strength of the whole plate will be the pitch of rivets multiplied by the thickness of the plate multiplied by the tensile strength of the plate per square inch, or,

$$7.25 \times .625 \times 55{,}000 = 249{,}218 \text{ pounds.}$$

The strength of net section of plate at outer row of rivet would be the width of plate minus the diameter of one rivet times the thickness and tensile strength, or,

$$(7.25 - 1) \times .625 \times 55{,}000 = 214{,}843 \text{ pounds.}$$

The shearing strength of a steel rivet, one inch in diameter, is 39,300 pounds and the shearing strength of the same sized rivet in double shear is 74,500 pounds, so that the total shearing resistance becomes

Strength of a 1-inch rivet in single shear = 39,300
Strength of 4 1-inch rivets in double shear = 298,000

Total shearing strength = 337,300

The shearing resistance being more than the strength of the net section of the plate, the efficiency becomes

$$214{,}843 \div 249{,}218 = 86.2 \text{ per cent.}$$

—[Ed.]

Formula for Polishing Slate.

EDITOR THE PRACTICAL ENGINEER:

Could you or any other engineer give me a preparation for cleaning polished slate, and how to use it? I have tried many different things but have found them to be of no value.

Chicago, Ill. F. M. D.

A formula given for polishing slate is as follows: Mix together seven parts of linseed oil, one part of ground ochre, three parts of tar oil and one part of asphaltum. Apply the mixture to the surface of the slate by means of a brush, and keep for some time in a hot room. When it is cooled off, polish with pumice stone and tripoli.—[Ed.]

Remedy for Kicking Pump.

EDITOR THE PRACTICAL ENGINEER:

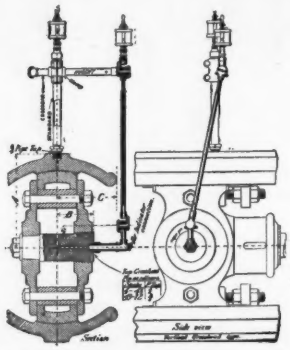
I have two boiler feed pumps of ample size with metal valves attached to an open heater. When the water passes a temperature of 200 degrees, the pumps have a little kick or jerk. While this does not interfere, it is, of course, bad on packing and wearing parts to be subjected to this jar. I do not want to use cold spray as I wish to get water to 208 degrees. I have a return for the vapor to the heater that leaves the suction pipe one-half the distance between the heater and the pumps. The water enters the suction chambers on both sides of pumps; two suctions to each pump with over 3 feet fall or head. I desire suggestions to remedy trouble.

Palm Beach, Fla. F. M. S.

This kicking of the pump can be remedied by lowering the pump so that there will be a greater head of hot water on it. Water at 200 degrees always gives off some vapor, especially when it is not under pressure and although there is a static head of 3 feet on the pump, this head is almost totally destroyed by the suction of the pump piston. The effect of this is to cause the cylinder to become full of vapor and since it offers less resistance than water, the piston moves faster for the moment or kicks. A greater head of water on the pump will prevent it.—[Ed.]

The Nugent Anti-Packed Telescopic Oiler.

The Nugent Anti-Packed Telescopic Oiler, which is shown in the accompanying illustration, is designed to lubricate any reciprocating bearing, such as the crosshead pin, eccentrics, and the double disc crank pin of steam engines and other similar bearings. The anti-packed joint is the new, novel and improved feature of this invention. The joints are $^1/_{100}$ of an inch loose and yet no oil can leak or waste through them. They have no stuffing boxes, washers or packing of any kind so that the friction, wear and jar are practically done away with, also all unsightly braces and guy rods. This device will outwear the engine or piece of machinery to which it is applied.



The Nugent Anti-Packed Telescopic Oiler.

This oiling device forms a continuous conduit or channel for the oil, from the stationary cup to the bearing which is to be lubricated. It will very much increase the life of the crosshead pin, which usually wears out as fast again as the crank pin, and it will save its cost in oil in a short time. It enables the engineer to know positively whether or not the bearing is getting oil, and it places the pin or bearing under the absoltue control of the engineer at all times and enables him to run his engine continuously for ten years, if necessary, without having

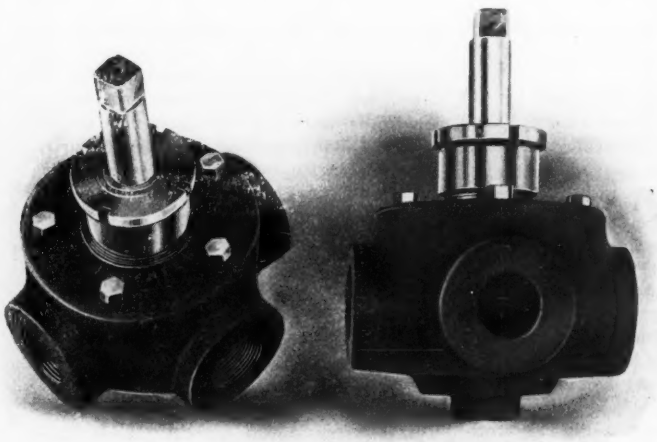
to stop to replenish the oil. By simply pulling out the two cotter pins with the fingers, the telescopic tubes and heads may be removed in a moment's time.

It is manufactured by Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill., who guarantee satisfaction or they will refund the purchase money any time within one year after date of purchase, if the oiler does not fulfil expectations.

The same firm manufacture special oiling devices for the Crank Pin, Eccentrics, Center Crank Engines, Lower Shoe of the Crosshead and Loose Pulleys. They also issue a valuable treatise on "How to Oil an Engine," which will be sent to any engineer or owner of an engine, free, upon request. It contains a lot of good pointers gathered by Mr. Nugent from practical experience while running, erecting and manufacturing engines. Any further information about oiling devices which may be desired will be given upon request.

The McCarthy Four-Way Valve.

Any engineer who has had to operate and take care of the ordinary plug-cock valve will appreciate many of the advantages of the four-way valve, shown in the accompanying illustration. The valve is built on the Corliss principle and does not leak; it is easy to work and requires no packing.



The McCarthy Four-Way Valve.

The body of the valve is made of cast-iron, in which are four openings which lead to the centre chamber. The centre chamber is ground to fit the Corliss valve, which only requires a slight angular motion to uncover the ports in the valve body. The valve disc is made of brass or cast-iron, as required. The valve stem passes up through the packing box and is always steam tight, and its construction is such that there is no packing required.

This valve is also used for straight away purposes or as a three-way valve and has given the same satisfaction as when used as a four-way valve.

As a four-way valve it has had a very large use in many of the largest iron and steel plants throughout the country for operating the cylinder on tunnel and bell and for various hydraulic and steam purposes where the four-way cock has been formerly used. It can be used on elevator systems and has been used as the valve of an engine by connecting the handle of the valve to the eccentric of the engine.

The particular disadvantage of four-way valves around iron plants was found to be that they leaked more steam than was required to do the necessary work. To overcome this difficulty, Mr. Felix McCarthy, who has been superintendent of the Warwick Iron and Steel Co. for the past twenty-four years, invented this four-way valve above-described, and they have been in use for a number of years without the sign of a leak.

Among the many other plants using them may be mentioned: Jones and Laughlin Co., of Pittsburg, where 223 are in use; Bethlehem Steel Co., Bethlehem, Pa.; Colorado Fuel and Iron Co., Denver, Col.; American Steel and Wire Co., Cleveland, Ohio; Dominion Iron and Steel Co., Nova Scotia, Canada; Crane Co., Birmingham, Ala.; Illinois Steel Co., Chicago, Ill.; Republic Iron and Steel Co., Youngstown, Ohio; Best Manufacturing Co., Pittsburg, Pa., and many other plants in this country and Europe.

For further particulars, address, Felix McCarthy, Pottstown, Pa.

The Western Electrical Directory.

The initial number of the Western Electrical Directory has recently been issued by the Blanchfield Publishing Company, of San Francisco, Cal. It should be particularly useful to those who desire to keep advised regarding the electrical situation in the West. It covers the western part of North America, including Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, Territory of Hawaii, British Columbia, Yukon Territory, Alberta, and a portion of Mexico.

The directory gives the names of companies or individuals operating electric light and power plants and electric railways; also, the names of companies which have been absorbed or succeeded. The capital stock and bonds of each company are given with the names of the officers, superintendents, purchasing agents, electricians, location and equipment of generating and sub-stations, location of main offices, mileage and number of cars operated by electric railways, and general information which is needful to those who desire to keep advised regarding these matters. A list of electrical contractors and dealers, and consulting and contracting engineers is also given. Price of directory is $5.00, which includes quarterly reports.

First Turbine Battleship.

A new 18,000 ton battleship is now building for the British navy and when completed will be the first vessel of its kind afloat. There are to be four sets of turbines mounted on four shafts and operating four propellers, each shaft being equipped with ahead turbines for high and low pressures and also with astern turbines. To get a high pressure, the boat will be equipped with water tube boilers and it is expected that the speed of the ship will be about 21 knots.

Can't be Beaten.

EDITOR THE PRACTICAL ENGINEER:

"The Practical Engineer" can't be beaten for good things for the practical engineer. I take four similar papers but I look forward to your paper coming more than to any of the others. It should be taken by every engineer in the land.

Sanger, Texas A. H. GOFF.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Peerless Rubber Manufacturing Co.'s name is so closely associated with Rainbow Packing that the many other brands of packing and rubber goods which they make should not be forgotten. While Rainbow Packing has had enormous sales, the other makes of packing which they manufacture and which keep their large factory at New Durham working full tilt, are as follows: Eclipse Sectional Rainbow Gasket, Peerless Piston and Valve Rod Packing, Peerless Expansion Ring Packing, Wizard Packing Rings, Wizard Moulded Gasket, Wizard Braided Wicking, Success Semi-Metallic Diagonal Expansion, Spiral Packing, Honest John Hydraulic Packing, Hercules Metallic Stop-Valve Packing, Rainbow Gaskets, Rings and Valves, Fortune, Peerless and Durham Brands of Rubber Belting and many other brands of engineering rubber goods.

Their magnificently printed new catalogue has recently been issued, describing these many products and besides contains many instructive pointers of value to the engineer. Write to Peerless Rubber Mfg. Co., 16 Warren Street, New York, for Catalogue No. 70.

Larkins' Self-Lubricating Metallic Packing is a combination of high-grade bearing metal in granular form with which the best quality of graphite is uniformly incorporated and all of which is encased in cotton tubing, thus making a packing that will fit any rod, and which is easy to apply. When the gland is tightened up, the tubing soon wears off, leaving a perfectly formed ring of pure metal and graphite which will wear for a very long time, and the graphite affords an ever-present lubricant for the rod. Pennsylvania Electrical and Railway Supply Co., Pittsburg, Pa., are the manufacturers.

The growing popularity of the Patterson-Berryman feed-water heater and purifier, manufactured by Frank L. Patterson & Co., 24 Cortlandt St., New York City, is best shown by the constantly increasing demand for them. We have just received a report from the manufacturers, giving a list of some of their recent installations, among which are the following: Westminster Knitting Mills, Westminster, S. C.; Hawke Stone Company, Meshoppen, Pa.; Greenwood Electric Light & Water Plant, Greenwood, Miss.; Eureka Steam Laundry, Pottstown, Pa.; Burrell, Miller & Brennor, Little Falls, N. Y.; Helena Gas Company, Helena, Ark.; Stewart Anthony, Pottstown, N. J.; Crown Knitting Mills, Toronto Junction, N. J.; E. Scholss & Co., New York City; Philadelphia Veneer and Lumber Company, Knoxville, Tenn.; Williams Grove Brick Company, Bigler, Pa.; Harvey Hubbell, Bridgeport, Conn.; Spaulding Manufacturing Company, Chicopee Falls, Mass.; Whitehall, Tatum Company, Millville, N. J.; Flandrau & Co., New York City; Chestnut Ridge White Brick Company, Lehigh Gap, Pa.; Hotel Margaret, Brooklyn, N. Y.; United States Express Company, Jersey City, N. J.; Sibley, Lindsey & Curr, Rochester, N. Y.; American Slate Company, Bangor, Pa.; Hotel Raleigh, Atlantic City, N. J.; Levi Stephenson, Johnstown, N. Y.; French Broad Granite Brick Company, Asheville, N. C.; John Beno Company, Council Bluffs, Iowa; S. R. Smith Infirmary, New Brighton, N. Y.; Smith-Phillips China Company, East Liverpool, Ohio; Detroit Belle Isle & Windsor Ferry Company, Detroit, Mich.; Municipal Electric Light Plant, Penn Yan, N. Y.,; Gainesville City Water-Works, Gainesville, Fla.; R. Hoen & Co., Brooklyn, N. Y.; Hollister Lumber Company, Rochester, N. Y.

A sample can of Philadelphia Grease will be mailed free to any reader of "The Practical Engineer" who will write at once to the Philadelphia Grease Mfg. Co., Bourse Bldg., Philadelphia.

Before deciding upon a steam pump for any service, write for catalogue to M. T. Davidson, 141 Broadway, New York. The Davidson pumps are noted for excellence of design and for the high quality of material and workmanship employed in their construction. It is often said by engineers that Davidson pumps give less trouble than any others.

A large list of premiums is offered by the France Packing Co., State Road, Tacony, Philadelphia, to users of France Packing. By cutting out and mailing the coupon which appears in their advertisement on page 62 of this issue, a start will be made toward securing one.

Many engineers say that a plug valve represents their ideal in valve construction, but that the great difficulty has been to get a plug valve that would not stick. This trouble is said to be entirely eliminated in the Cadman Split-Plug valve. The Cadman Blow-off valve is also noted for its reversible seat and disc, and is said to be leakless and practically indestructible. Any reader who is interested in either of these types of valves should write for catalogues and price list to A. W. Cadman Mfg. Co., Pittsburg, Pa.

A steam boiler may be the most economical, or it may be the most extravagant and wasteful feature of a power plant. Which it is depends largely upon its condition, and its condition depends chiefly upon the feed water and its treatment. The treatment usually depends upon the engineer; at least, he is the one who gets the credit or the blame. The wise engineer does not wait for scale to form and then mine it out; he prevents scale from forming, thus keeping his boilers always at their highest state of efficiency, and in no way can this be done better than with a Buckeye Automatic Boiler Skimmer. This machine is growing rapidly in popularity and every engineer who adopts it seems to be well pleased with the results. We have never heard of a failure. This machine is fully described in a catalogue issued by its manufacturers, Buckeye Boiler Skimmer Co., Colburn Ave., Toledo, Ohio.

John R. Livezey, 1936 Sansom St., Philadelphia, the well-known pipe covering man and expert on cold storage insulation, has recently added two more good men to his force of field representatives: Lewis F. Hopper and Frank E. Emery. Both of these young men are well known and popular.

The Harris Oil Company, 320 South Water St., Providence, R. I., have published a mighty interesting and instructive booklet on the subject of lubrication, a copy of which they will send to any reader of "The Practical Engineer" who sends them his name and address before the edition is exhausted. Also mention "The P. E."

An automatic positive feed lubricator represents the most advanced method of lubrication and in order to more quickly prove the advantages of their new Improved Rochester lubricator, Green, Tweed & Co., 17 Murray St., New York, are offering for a short time to send one on 30 days' free trial.

This is the best season of the year to take up a course in correspondence instruction. The long winter evenings cannot be employed to better advantage for the knowledge which it is possible to acquire before the blue birds nest again and it will be worth many times the small effort and expense to any young or ambitious engineer. We understand that the International Correspondence Schools are making a specially attractive offer just now to new students enrolling for their engineering courses. Those wishing to have full details concerning the cost of these courses, etc., should address their inquiries to P. O. Box 835, Scranton, Pa.

The Burt Manufacturing Co., Akron, Ohio, are doing a rushing business. They have just shipped one 20-inch Exhaust Head to the Crane Co., Chicago, and another to the large power house at San Jose, Cal., also one of the large Cross Oil Filters to the United States Coal and Coke Co., for use in their mines in West Virginia.

If you are troubled with dust anywhere in your establishment, write to the Sterling Pipe and Blower Co., Hartford, Conn., and tell them the conditions. This company builds special apparatus for removing dust of any character from any establishment.

The Greacen-Derby Engineering Co., Perth Amboy, N. J., build an excellent type of mechanical filter, especially designed for filtering boiler feed water. A booklet describing it in detail will be mailed for the asking to anyone mentioning "The Practical Engineer."

If you have a bad bearing which insists upon getting hot just at the wrong time, try Mica Flake, a sample of which will be sent free to any engineer or power user by O. & W. A. Worner, 1529 Porter St., Philadelphia, Pa.

Write for samples of the Lubron hot-water washers. You cannot wear them out or break them, no matter how hot the water. Also if you are not fully satisfied with the pump valves

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you are using, try the Lubron valves. A sample valve will be sent you free for trial if you will state exact size wanted and where it is to be used; also mention "The Practical Engineer." Address, Lubron Mfg. Co., 88 Broad St., Boston, Mass.

A new catalogue has just been published by Jas. McCrea & Co., 63 West Washington St., Chicago, Ill. It describes and illustrates quite fully their line of clamps for stopping leaks in steam pipes, including several styles of their well-known Climax Clamp, which is recognized as the standard in its line; their Emergency clamp for repairing leaks and splits in either steam, water or brine pipes, and their Model Flange clamp for stopping leaks that occur between pipe flanges. It also describes the "H. H." steam trap, The Butman Patent Flue Cleaner Rod, The Century Gasket Cutter, Century Drilling Machine and the Wernicke Boiler Tube Cutter for cutting off boiler tubes either inside or outside the boiler.

The Detroit Lubricator Co., Detroit, Mich., have just issued an unusually attractive and interesting new catalogue, a copy of which will be mailed to any reader of "The Practical Engineer," upon request. In addition to describing their full line of sight-feed lubricators, this new catalogue describes their line of glass oilers, gas engine lubricators, pressure oilers and automobile pumps, locomotive lubricators, compression cocks and water gauges. Every engineer ought to have a Detroit catalogue.

John T. Lindstrom, 214 S. Third St., Allentown, Pa., has issued a new pamphlet describing his Superheater Steam Separator and Corliss Valve Steam Trap, copies of which he will send to anyone interested.

The cessation of hostilities in the far East has already been emphasized by the fact that export orders are being received in America for large quantities of supplies and equipment.

As usual, the Geo. W. Lord Company are coming in for their share of this business and have resumed shipment of Lord's Boiler Compounds to Japan and Russia. They have, since the signing of the treaty of peace, in addition to filling standing orders, received a cable order from their Vladivostock agent for a carload of Compound to be shipped direct via Seattle, Washington.

For the past ten years they have been making shipments regularly to all the far Eastern countries.

ADVERTISING ENGINEERS.

Products of scientific manufacture require promotion even more than do commercial articles of general consumption. The engineer or manufacturer who has spent years of work and thought upon the perfection of a new product or machine accepts as axiomatic that, because there is a need for it, there will be a demand. He forgets that before his possible customers will give up their accustomed and familiar methods, to adopt the new, they must to some degree pass over the same mental course that he has traversed, and, unless educational measures are adopted, this is apt to be a matter of many years. To introduce his improvements in steam engine valve gears, Corliss was forced practically to giving his machines away. The Parsons steam turbine was an engineering success ten or twelve years before it became a commercial success in this country. On the other hand, the turbine centrifugal pump, by modern advertising methods, has been made commercially successful in a period of two years, the sales of the third year being four times those of the first, while a prominent cordage manufacturer has increased the sales of his transmission rope twenty times over within a few years by means of advertising.

Not only, however, do engineering products require an educational publicity campaign for their introduction within reasonable time, but all the methods of general advertising, suitably modified, are in some way applicable in promoting their sale. There is a science of economy of communication and apprehension, as of other things, and some ways of overcoming psychological inertia are less expensive and attended with less friction than others.

Recognizing these facts, some engineering and manufacturing concerns have established advertising departments and have placed them in charge of men of high ability. This plan, however, is more expensive than most businesses justify and many firms attempt to handle the work through already overburdened executive officers or else turn it over to clerks.

To meet these conditions, Mr. Halbert P. Gillette, M. Am. Soc. C. E., M. Am. Inst. M. E., formerly Associate Editor of Engineering News, and Mr. Geo. H. Gibson, A. M. Am. Inst. E. E., J. M. Am. Soc. M. E., formerly Manager of Publicity for the International Steam Pump

Co., manager of the advertising department of the B. F. Sturtevant Co., and editor of the Westinghouse Companies' Publishing Department, have formed a partnership as "advertising engineers," under the name of the Geo. H. Gibson Co., with offices in the Park Row Bldg., New York City. They undertake to conduct a firm's advertising in the same manner as would a department in the firm's own offices.

Do you know anything about the operation of the Monarch Engine Stop and Speed Limit System? Perhaps not; it's something you don't meet with in every establishment, but every engineer ought to know as much about it as possible. Any reader of ours who wants a good description of this interesting system will be furnished with same if he will write to the Consolidated Engine Stop Co., 100 Broadway, New York, and ask them to send one of those special booklets mentioned in "The Practical Engineer."

"Empire" packing is said to be the first fibrous packing ever made with a rubber core, and the makers tell us that the rubber which they now use in the manufacture of "Empire" is of the same high quality that was used forty years ago.

The principal reason why every steam boiler is not equipped with a Buckeye Boiler Skimmer is probably because there are many engineers who do not fully understand them; for it seems unreasonable to permit scale and dirt to accumulate in a boiler when it can be prevented so easily and cheaply. The manufacturers of the Buckeye Skimmer have recently sent us a large number of original letters received by them from time to time from users of their skimmers, all of which tell of excellent results and which collectively go to prove that this type of cleaner can be applied successfully to any make of boiler. Copies of these letters are printed in an attractive booklet, one of which will be mailed free to any of our readers upon writing The Buckeye Boiler Skimmer Co., Colburn Ave., Toledo, Ohio.

That the mechanical stoker is coming into more general use and growing in popularity with engineers, particularly the Wilkinson Stoker manufactured by the Wilkinson Mfg. Co., Bridgeport, Montgomery County, Pa., is evident from the fact that within the past few weeks the Wilkinson Company have received the following large orders: U. S. Navy Yard, Washington, D. C., 1500 horse power of stokers; Schwarschild & Sulzberger, New York City, 700 horse power of stokers; Norristown Electric Light and Power Co., 400 horse power of stokers; W. B. Moses & Sons, Washington, D. C., 350 horse power of stokers; The Franklin Laundry, Washington, D. C., 200 horse power of stokers.

A new power plant and factory supply company has just been incorporated under the laws of the State of Illinois, the name of which is the Calumet Supply Co., with stores at 411-413 Dearborn St., Chicago. The stores also have a large frontage on Plymouth Court, which will permit of an attractive window exhibit. The active members of this new concern are Mr. J. S. Ward and Mr. Frank M. Gilmore. The exclusive selling agencies for several representative manufacturers has already been secured and the company desire to get into correspondence with other manufacturers who are looking for selling representatives for Chicago and vicinity.

The Golden-Anderson Valve Specialty Co., of 115 Pipe St., Pittsburg, Pa., are the makers of many specialties which are in general favor because of their many merits. These include the Anderson cushioned non-return valve, Anderson cushioned triple-acting non-return valve, the Golden patent tilting steam trap, the Anderson patent balanced plug cock and the Anderson patent regulating valve. These and other specialties are described in their new booklet, which will be sent free upon application, to any reader of "The Practical Engineer."

One of the finest catalogues that has come our way recently is the one issued by the De La Vergne Refrigerating Co., 138th St., New York City, entitled, "Koerting Gas Engines." It contains a complete description of the various terms used in gas engine practice, together with a complete description of the Koerting four-cycle gas engine. The question of producers is taken up and a description of a suction gas plant is given in detail. The latter part of the catalogue is filled with useful tables about gases. A copy of this catalogue will prove useful to any engineer interested in gas engines.

The Lagonda Mfg. Co., Springfield, Ohio, who are very well known as the manufacturers of Weinland boiler tube cleaners, damper regulators and other engineering specialties, inform us that they have enjoyed an unusually good business during the past month; so much so indeed, that they were obliged to run their shops all night for more than half the month. They state that they have never before been so crowded with work, which they think indicates that the users of tube cleaners recognize the superior merit of the "Weinland."

Agents Wanted to solicit Subscriptions for The Practical Engineer. Commission basis. Can make from $20 to $40 a week if you are a hustler.
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J. L. TILLMAN
521 Colburn Street, Toledo, Ohio

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co.
Tacony, Phila., Pa.

Wanted. Agents and Steam Specialty men to handle the Swan Patent Piston and Packing. The best ever made. George P. Rogers, 305 Bartlett Bldg., Atlantic City, N. J.

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Engineers who have tried same claim it to be the best yet.
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A trial will convince you
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GRAPHO MFG. CO.
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ROCHESTER, N. Y.

Bridgeman Bros., of Philadelphia, installed all the piping on the water and air lines in the recently completed Spring Lake Pumping Station. The capacity of the plant is 2,500,000 gallons a day and the water is lifted from artesian wells by compressed air.

In their new catalogue, No. 6, Charles Bond, of 518 Arch St., Philadelphia, describes a complete line of power transmission machinery and leather belting manufactured by them. These include pulleys, shafting, hangers, pillow-blocks, chain belting, etc. They also handle mine, mill, engineers', machinists' and railroad supplies, each line of which is well illustrated, so that this 225-page book should be a valuable addition to any engineer's library.

The National Steam Specialty Co., of 325 Frisco Bldg., St. Louis, Mo., agents for the Keller Steam Economizer, recently made a test on one of the well-known types of open heaters, in which they found that the loss in temperature in going through the feed pump, after passing the heater, was sometimes as high as 40 degrees, depending on the speed of the pump; the slower the speed of the pump, the greater the difference of temperature between the feed water heater and water entering boiler.

With the Keller Economizer, the feed water is heated after passing the pump and will feed the boiler at 212 degrees constantly, and the slower the feed water flows, the hotter it is made by this device. Every engineer who is interested in increasing the heat of the feed water entering the water and thus saving coal should write for a catalogue of the Keller Economizer. A card mentioning "The Practical Engineer" will bring you one.

A catalogue which fully describes and illustrates the Buffalo Forge Engine will be sent to any reader of The Practical Engineer upon request. Address The Buffalo Forge Co., N. Y. and mention The Practical Engineer.

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